UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
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NOV 29 2005

MEMORANDUM FOR: Scientific Research Permit No. 1440, 151422SWR2003SA8941:JSM

FROM: for Rodney R. McInnis A G Morton
Regional Administrator

SUBJECT: Addendum to the Central Valley Programmatic Biological Opinion for Scientific Research, Northern and Central Coast Programmatic Biological Opinion for Scientific Research, and Conference Opinion for the Southern Distinct Population Segment of North American green sturgeon

I. CONSULTATION HISTORY

Section 10(a)(1)(A) of the Endangered Species Act of 1973, as amended, (ESA) provides NOAA's National Marine Fisheries Service (NMFS) with authority to grant exceptions to the ESA's taking prohibitions for scientific research (see regulations at 50 CFR 222.301 through 222.308 and 50 CFR 224.101 through 224.102). Scientific research or enhancement permits may be issued to Federal or non-Federal entities conducting research or enhancement activities that involve take of ESA-listed endangered or threatened species. Any permitted research or enhancement activities must: (1) be applied for in good faith; (2) if granted and exercised, not operate to the disadvantage of the endangered species; and (3) be consistent with the purposes and policy set forth in section 2 of the ESA (50 CFR 222.303(f)). NMFS addressed the effects of the proposed research on listed salmonids by preparing this addendum to the Central Valley programmatic biological opinion for scientific research (Central Valley Research Opinion; NMFS 2003a) and Northern and Central Coast programmatic biological opinion for scientific research (Northern and Central Coast Research Opinion; NMFS 2002a), signed on September 5, 2003, and October 22, 2002, respectively, in compliance with section 7(a)(2) of the ESA (16 U.S.C. 1536). This document also includes NMFS' conference opinion on the effects of the proposed research on the proposed threatened Southern Distinct Population Segment (DPS) of North American green sturgeon (*Acipenser medirostris*). In the event that the Southern DPS of North American green sturgeon are listed as threatened, NMFS will review the project description and confirm the conference opinion as a biological opinion if there are no significant changes to the action.

On April 14, 2003, the Interagency Ecological Program (IEP) submitted an application to NMFS for a research permit to conduct an interagency ecological monitoring program in the San Francisco Estuary (Estuary), which includes the Sacramento-San Joaquin Delta (Delta). The IEP is an interagency organization that comprises 10 member agencies: 6 Federal (U.S. Fish and Wildlife Service (USFWS), Bureau of Reclamation, Geological Survey, Army Corps of Engineers, Environmental Protection Agency, and NMFS), 3 State of California (Department of Water Resources, Department of Fish and Game (CDFG), and State Water Resources Control Board), and 1 non-governmental organization (The San Francisco Estuary Institute). The IEP organization seeks to gather and provide information on the ecology of the Estuary and the effects of the State and Federal Water Projects on the Estuary. The IEP had previously received ESA-take coverage from a biological opinion that was issued to the Bureau of Reclamation on June 18, 1998. That incidental take coverage expired on June 18, 2003. In 2003, the IEP decided it was more appropriate to apply for ESA-take coverage through section 10(a)(1)(A).

The original request for a research permit, dated April 14, 2003, covered 12 research and monitoring projects. On June 16, 2003, IEP submitted a written request to remove 1 project, "The Rock Slough fish monitoring study," from the program. On March 5, 2004, IEP submitted a written request to add 3 new projects to the program that examine the effects of the State and/or Federal water projects' fish protective facilities' processes of fish collection, handling, transport, and release (CHTR) on delta smelt. On August 9, 2004, IEP submitted a written request to add 1 new project, "Morrow Island distribution system diversion evaluation," and remove 3 projects from the original permit request: "Evaluation of adult fall-run Chinook salmon, white sturgeon, and striped bass movement in north Delta and Delta Cross Channel," "Shallow water habitat predator-prey dynamics," and "Adult fall-run Chinook salmon passage at the Suisun Marsh Salinity Control Gates." On February 10, 2005, IEP requested a modification to the permit to include 3 additional studies titled: "Adult striped bass population parameters monitoring," "Fall midwater trawl," and "Adult sturgeon tagging studies." This consultation, therefore, covers a total of 15 projects that reflect the entire history of IEP's written requests. In addition, information concerning take of North American green sturgeon as a result of IEP research activities was requested by NMFS on April 21, 2005, as a result of the proposed listing of the Southern DPS of North American green sturgeon as threatened on April 6, 2005. NMFS received historical North American green sturgeon catch information from the IEP on May 18, 2005. The resultant biological and conference opinion covers all 15 IEP projects for listed salmonids and the proposed listing of the Southern DPS of North American green sturgeon.

This biological and conference opinion addresses effects of the monitoring program to ESA-listed endangered Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), threatened Central Valley spring-run Chinook salmon (*O. tshawytscha*), threatened Central Valley steelhead (*O. mykiss*), threatened Central California Coast steelhead (*O. mykiss*), and proposed threatened Southern DPS of North American green sturgeon and designated critical habitat for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and Central California Coast steelhead. NMFS published a notice of receipt of IEP's permit application in the *Federal Register* on August 18, 2003 (68 FR 49438), announcing the beginning of a 30-day public comment period. One person responded favorably to the notice within the 30-day comment period and provided comments on the proposed program.

II. DESCRIPTION OF THE PROPOSED ACTION

Under the authority of section 10(a)(1)(A) of the ESA, NMFS proposes to issue Scientific Research Permit No. 1440 (Permit 1440) to IEP authorizing take of listed Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, Central California Coast steelhead; and proposed Southern DPS of North American green sturgeon. The permit would be in effect through June 30, 2015, and would be subject to the limitations of the ESA and the regulations in 50 CFR parts 222, 223, and 224, for the period stated on the permit unless it is modified, suspended, or revoked sooner.

A. Research Project Description

In a request for Permit 1440, the IEP proposes to conduct 15 fisheries-related studies to provide ecological information for use in the management of the Estuary, including the Delta (Table 1). These include long-term monitoring projects and short-term projects to study the trends in abundance, distribution, and species interactions of resident and anadromous fishes and invertebrates (*e.g.*, delta smelt *Hypomesus transpacificus,* Sacramento splittail *Pogonichthys macrolepidotus,* Chinook salmon *Oncorhynchus* spp., sturgeon *Acipenser* spp., crabs, shrimp, *etc.*). There are 10 long-term monitoring projects that are projected to continue into the foreseeable future and 5 short-term projects that will terminate at the end of 2006. The majority of these projects target non-listed salmonids and 1 long-term project targets North American white sturgeon (*Acipenser transmontanus*). Therefore, salmonid and sturgeon catch is likely. A summary of the study objectives, study locations, sampling times and frequency, and sampling gear used for each project is provided in Table 1.

In general, sampling will occur in the Estuary and Delta (Figure 1) varying from seasonal to year-round sampling, with frequency ranging from daily to monthly (Table 1). The sampling methods include both passive and active-capture techniques, with the use of entanglement gears (*e.g.*, nets), entrapment devices (*e.g.*, fyke nets), trawls (*e.g.*, midwater, otter, tow net), and electrofishing. A few of the studies will employ a combination of sampling methods, while most will use only 1 method to collect samples (see Table 1).

1. <u>Long-Term Monitoring Projects</u>

Project 1, "Adult striped bass population parameters," will use 4 sampling gears in the Lower Sacramento and San Joaquin Rivers, Sacramento River at Knights Landing, and Clifton Court Forebay. Gill nets will be set to drift at 4 stations in the western Delta, primarily in Broad Slough and the lower Sacramento and San Joaquin rivers 5 days per week between April 1 and July 15. Up to 120 anchored gill net sets will be done in Clifton Court Forebay between February and November. Up to 360 angler-hours of hook-and-line sampling also will be conducted in Clifton Court Forebay between February and November. Fyke traps will be set on the left bank of the Sacramento River at Knights Landing 7 days per week between March 15 and July 15. This project has been ongoing since 1969.

Project 2, "Fall midwater trawl," will involve sampling 7 to 8 days at the beginning of each month from September through December. A total of 116 stations will be sampled during each monthly survey from south of the Dumbarton Bridge in San Francisco Bay upstream to Rio Vista in the Sacramento River and False River on the San Joaquin River. All captured fish will be identified, measured, and released shortly after capture. Fin-clipped Chinook salmon will be euthanized and placed in plastic bags for coded-wire tag (CWT) identification. This project has been ongoing since 1967 (except for years 1974 and 1979).

Project 3, "Adult sturgeon tagging," will involve sampling 5 days per week from August through October in San Pablo Bay. Drift gill nets will be set for approximately 20-40 minutes per day for a maximum of 4 sets a day. Salmonids will be released immediately upon revival and both green and white sturgeon will be tagged and released immediately. This project has been ongoing approximately every 2 to 3 years since 1954.

Project 4, "Delta resident shoreline fish monitoring," will involve sampling monthly throughout the year using boat electrofishing at randomly-selected sites, each measuring 0.5 km along the shoreline (*e.g.,* 5 sites randomly selected in the east and central Delta, 3 sites in the north and west Delta, and 4 sites in the south Delta). Between 1 and 2 sites will be sampled per day for the first 3 weeks of the month. Fish will be revived in an aerated holding tank immediately when captured and all listed fish are released immediately upon revival. This project has been ongoing from 1978 to 1985, and 1995 to the present.

Project 5, "Estuarine and marine fish abundance and distribution survey," will involve sampling monthly throughout the year using both a midwater trawl (towed for 12 minutes) and otter trawl (towed for 5 minutes) at 52 stations from South San Francisco Bay to the western Delta (see Appendix 1 for exact sampling locations). All captured fish will be identified, measured, and released shortly after capture. Fin-clipped Chinook salmon will be euthanized and placed in plastic bags for CWT identification. This project has been ongoing since 1979.

Project 6, "Delta smelt 20-mm survey," will involve sampling for delta smelt every 14 days for 6 consecutive days near neap tidal periods from March through August using a plankton net for 3, 10-minute tows throughout the water column at 41 stations from San Pablo Bay to the eastern Delta (see Appendix 2 for exact sampling locations). No salmonids are targeted in this study. This project has been ongoing since 1995.

Project 7, "Real-time monitoring," will involve sampling 5 days per week from April through June using a Kodiak trawl towed by 2 boats for 10, 20-minute tows per day at Mossdale in the San Joaquin River (25 feet wide by 6 feet deep, by 65 feet long). Adipose fin-clipped juvenile Chinook salmon are retained for decoding of CWT at the USFWS Stockton office. This project has been ongoing since 1995.

Project 8, "Spring Kodiak trawl survey," will sample during February and March using a Kodiak trawl towed for 10 minutes at 38 stations from the Napa River to Walnut Grove on the Sacramento River, and to Stockton on the San Joaquin River (see Appendix 3 for exact sampling locations). The sampling stations are shared with the "Delta smelt 20-mm survey" stations, and are taken over a 4-day period, with a 2-day resampling period at sites with the highest abundance of delta smelt. All captured fish will be identified, measured, and released shortly after capture. Adipose fin-clipped juvenile Chinook salmon will be euthanized and retained for decoding of the CWT at the USFWS Stockton office. This project has been ongoing since 1991.

Project 9, "UC Davis Suisun Marsh fish monitoring," will involve sampling monthly throughout the year using an otter trawl towed for 5 minutes in small sloughs and 10 minutes in large sloughs and a beach seine (4 hauls) in sloughs of the Suisun Marsh (see Appendix 4 for exact sampling locations). This project has been ongoing since 1979.

Project 10, "South Delta temporary barriers fish monitoring," will involve sampling 24 hours daily in April and May using fyke nets to enclose 6 culvert outfalls at the Head of Old River. The nets are checked daily at the end of each high and low tide. Juvenile fall-run Chinook salmon will be released upstream and recovered in nets attached to the culverts to study diel-tidal effects on fish entrainment. All salmonids will be measured, and adipose fin-clipped Chinook salmon will be euthanized and retained for CWT processing. This project has been ongoing since 1997.

2. <u>Short-term Projects</u>

Project 11, "Yolo Bypass fish monitoring," will involve the use of 5 different sampling gears in the Yolo Bypass to investigate the dynamics of fish use of floodplains. A drift gill net is fished for 30 minutes monthly on an ebb tide during unflooded conditions and weekly during inundated conditions for a total of 20 samples. A rotary screw trap samples in the Toe Drain during ebb tides daily from January through June. Beach seining is done at 2 to 5 stations on the perimeter of the inundated Yolo Bypass and at 3 stations during unflooded periods (*i.e.,* at the Yolo basin wetlands "study pond," pond below Fremont Weir, and a shoal near the Toe Drain). A fyke trap samples daily from October through June in the Toe Drain near levee mile 6.5. A larval fish net samples once monthly on an ebb tide during unflooded conditions and every 2 weeks during flooded conditions in the Yolo Bypass. Another component of the project involves releasing 4 groups of 50,000 tagged hatchery Chinook salmon fry for recovery downstream. All fish will be measured and released shortly after capture. Adipose fin-clipped Chinook salmon will be euthanized and retained for CWT processing. This project started in 1998 and will continue through at least 2006.

Project 12, "Development of diagnosis indicators to predict acute or chronic adverse effects to salvaged delta smelt," will involve sampling from October through December using purse seines (15-minute soak time, 2-12 sets per day, 3-4 days per week) in Montezuma Slough east to Horseshoe Bend near the Sacramento River. The project captures delta smelt to assess sublethal effects of the State and Federal fish collection facilities' processes of CHTR on delta smelt. This is a 3-year study targeting delta smelt and will be conducted through 2006.

Project 13, "Assessment of fish predation occurring in the collection, handling, transport, and release phase of the State Water Project's John E. Skinner Delta Fish Protective Facility salvage operation," will use fish salvaged at the Tracy Fish Collection Facility from January through

June to examine fish predation during the CHTR process. This study does not collect fish from the wild, but uses fish that have already been collected at the fish facility. This is a 2-year study that does not target listed salmonids and will be conducted through 2005.

Project 14, "Acute mortality and injury to delta smelt associated with collection, handling, transport, and release at State Water Project and Central Valley Project Fish Salvage Facilities," will involve sampling from May through July, and December through March using a purse seine (15-minute soak time, 2-12 sets per day, 3-4 days per week) in Montezuma Slough east to Horseshoe Bend near the Sacramento River. The project is intended to measure acute mortality and injury rates of delta smelt during high entrainment periods. This is a 3-year study targeting delta smelt and will be conducted through 2006.

Project 15, "Morrow Island distribution system diversion evaluation," will involve sampling in September, February, March, and May using purse seines in Goodyear Slough and fyke nets (sampled 16 individual 24-hour sessions when listed species are present) in the Morrow Island distribution system (MIDS) intakes. Timing of sampling at Goodyear Slough will depend on the operation of the MIDS and UC Davis' Suisun Marsh fish monitoring program, but generally will include 16 individual 24-hour blocks throughout the MIDS operating season. The project is intended to compare entrainment losses of fish at the MIDS intakes over several tidal and diel cycles and under various operational configurations. This is a 3-year study to be conducted through 2006.

B. Description of the Action Area

Sampling will occur in the Sacramento-San Joaquin Estuary including the Delta (Figure 1). The sampling area is approximately bordered to the south by the Dumbarton Bridge in San Francisco Bay and Mossdale on the San Joaquin River to the north by Knights Landing on the Sacramento River. The many channels and sloughs of the Delta as well as portions of tributaries to the San Francisco Bay are included in the sampling area. Specific sampling sites are described in Table 1 and Appendices 1-4.

C. Requested Amount of Take

1. <u>Listed Species</u>

The cumulative take resulting from all 15 IEP projects described above may result in nonlethal take of 36 adult and 165 juvenile Sacramento River winter-run Chinook salmon, 100 adult and 950 juvenile Central Valley spring-run Chinook salmon, 39 adult and 634 juvenile Central Valley steelhead, and 2 juvenile Central California Coast steelhead (Table 2). Approximately 20 percent of the adult nonlethal take, and 66 percent of the juvenile nonlethal take is expected to result from the short-term projects (Figure 2).

All estimated lethal take is expected to be unintentional (Table 2). From the salmonids that are captured or handled, the applicant estimates a potential lethal take totaling no more than 8 percent adult and 10 percent juvenile Sacramento River winter-run Chinook salmon, 9 percent adult and 7 percent juvenile Central Valley spring-run Chinook salmon, and 8 percent adult and 3 percent juvenile Central Valley steelhead to result from the proposed projects (Figures 4 and 5). No lethal take of Central California Coast steelhead is expected. Expected lethal take of adult winter-run Chinook salmon is 1 in short-term studies and 2 in long-term studies (Figure 3). Expected lethal take of adult spring-run Chinook salmon is 1 in short-term studies and 9 in long-term studies (Figure 3). Expected lethal take of adult Central Valley steelhead is 1 in short-term studies and 2 in long-term studies (Figure 3).

2. <u>Proposed Species</u>

The cumulative take resulting from all 15 IEP projects described above may result in nonlethal take of 254 juvenile or adult North American green sturgeon (Figure 6, Table 3). Less than 4 percent of the juvenile and/or adult take is expected to result from the short-term projects (Figure 6).

All estimated lethal take is expected to be unintentional (Table 3) and the applicant estimates a potential lethal take totaling no more than 11 North American green sturgeon representing approximately 4 percent of the total take (Figure 6, Table 3). All lethal take is expected to occur as a result of long-term projects (Figure 6, Table 3).

D. Measures to Reduce the Impacts of Issuing Permit 1440

Following are measures to be implemented to minimize any adverse impacts on ESA-listed salmonids and North American green sturgeon during research activities:

a. NMFS has reviewed the credentials of the principal investigators for the proposed research projects. All investigators are well qualified and have provided evidence of experience working with salmonids and/or North American green sturgeon or the concepts outlined in the proposed projects.

b. NMFS has developed nondiscretionary conditions for Permit 1440 that are necessary and appropriate to minimize take of ESA-listed salmonids, as described in the permit and Appendices A and B of the Central Valley Research Opinion and Central and Northern Coast Research Opinion. The investigators will ensure that all persons operating under Permit 1440 are familiar with the terms and conditions therein.

c. NMFS will monitor project activities to ensure that the project is operating satisfactorily in accordance with Permit 1440. NMFS will monitor actual annual take of ESA-listed species associated with the proposed research activities (as provided in annual reports or by other means) and will adjust annual permitted take levels if they are deemed to be excessive or if cumulative take levels are determined to operate to the disadvantage of listed fish.

d. All persons operating under Permit 1440 will be properly trained and have access to properly maintained state-of-the-art equipment.

e. All listed fish captured will be processed immediately and before any other fish are processed, and returned to the water.

f. All traps must be checked and cleared of fish and debris daily.

g. All electrofishing will be conducted by field crew personnel trained and experienced with electrofishing techniques. Researchers for the project using electrofishing shall follow, "NOAA Fisheries Guidelines for Electrofishing Waters Containing Salmonids Listed Under the Endangered Species Act, June 2000" (http://www.nwr.noaa.gov/1salmon/salmesa/4ddocs/final4d/electro2000.pdf). Electroshocked fish will be held in live wells and allowed to recover before being released at the location of capture.

h. All ESA-listed salmonids unintentionally killed during sampling activities will be preserved as voucher specimens and sent to: Salmonid Genetic Repository, Southwest Fisheries Science Center, 110 Shaffer Road, Santa Cruz, California 95060, (831) 420-3903, for Chinook salmon; Ms. Katie Perry, California Department of Fish and Game, 830 S Street, Sacramento, California 95814, (916) 445-4506, for Central Valley steelhead. Preservation protocol should be confirmed with the appropriate contact person.

i. All North American green sturgeon unintentionally killed during sampling activities will be preserved as voucher specimens and sent to: Mr. Bernie May, Genomic Variation Lab, Department of Animal Science, 2403 Meyer Hall, University of California, Davis, CA 95616. Contact Josh Israel at University of California, Davis for preservation protocol and questions at jaisrael@ucdavis.edu or at (530) 752-6351.

III. STATUS OF THE SPECIES AND CRITICAL HABITAT

A. Listed Species

The issuance of Permit 1440 may potentially affect the Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and Central California Coast steelhead Evolutionary Significant Units (ESUs). The Central Valley Research Opinion describes the status of the Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead ESUs, and the Central and Northern Coast Research Opinion describes the status of the Central California Coast steelhead ESU. The current status of the above listed salmonids, based on their risk of extinction, has not significantly improved since the species were listed (Good *et al.* 2005).

Fisher (1994) estimated a historic winter-run Chinook salmon spawning population size of approximately 200,000 fish based on monthly commercial fishery landing records and known migration characteristics. Populations reached a peak of 100,000 in the late 1960s and have dropped monotonically since (Good *et al.* 2005). Sacramento River winter-run Chinook salmon runs reached a low of fewer than 200 fish in 1994, and increased to over 8,000 fish in 2003, averaging 5,614 between 1999 and 2003 (CDFG 2002 unpublished data). Although the number of Sacramento River winter-run Chinook salmon has increased slightly in the last 7 years, the ESU remains at risk of extinction. Two current methods are utilized to estimate the juvenile production of Sacramento River winter-run Chinook salmon: the Juvenile Production Estimate (JPE) method, and the Juvenile Production Index (JPI) method (Gaines and Poytress 2004). Gaines and Poytress (2004) estimated the juvenile population of Sacramento River winter-run Chinook salmon exiting the upper Sacramento River at Red Bluff Diversion Dam to be 3,707,916 juveniles per year using the JPI method between the years 1995 and 2003 (excluding 2000 and 2001). Using the JPE method, they estimated an average of 3,857,036 juveniles exiting the supper Sacramento River at Red Bluff Diversion Dam between the years of 1996 and 2003 (Gaines and Poytress 2004).

Central Valley spring-run Chinook salmon have displayed broad fluctuations in abundance over time. Historic population abundance was estimated to be approximately 700,000 spawners per year (Fisher 1994). Their numbers have decreased to approximately 1,500 in 1992 to approximately 25,000 in 1998, and nearly 9,000 in 2003 (CDFG unpublished data). The average population size of the Central Valley spring-run Chinook salmon ESU as depicted by escapement estimates between 1992 and 2003 is 12,499 (CDFG unpublished data).

The widespread occurrence of Central Valley steelhead and the similar distribution with spring-run Chinook salmon prompted McEwan (2001) to estimate population levels between 1 and 2 million spawners. Central Valley steelhead populations were approximately 11,000 adult fish in the late 1960s and 1970s and approximately 2,000 fish through the early 1990s (McEwan 2001). Recent estimates from trawling data in the Delta indicate that approximately 100,000 to 300,000 smolts emigrate to the ocean per year representing approximately 3,600 female Central Valley steelhead spawners in the Central Valley basin (Good *et al.* 2005). Population estimates of the Central California Coast steelhead ESU approximated 94,000 fish in the 1960s and numbers have declined to less than 5,500 in recent times (Busby *et al.* 1996). Although their abundance is low, Central California Coast steelhead are fairly well distributed throughout their current range. The ESU's relatively broad distribution is a positive indicator of the species likelihood of survival and recovery in the wild (62 FR 43937).

The factors affecting the species and their habitats include: (1) dam construction that blocks previously accessible habitat, (2) water development activities that affect water quantity, water quality, and hydrographs, (3) land use activities such as agriculture, flood control, urban development, mining, and logging, (4) hatchery operation and practices, (5) harvest activities, (6) ecosystem restoration actions, (7) natural conditions, and (8) scientific research. Large dams are present on almost every major tributary to the Sacramento and San Joaquin Rivers, and block salmon and steelhead access to the upper portions of watersheds that represent approximately 80 percent of historical habitat. For the Central California Coast steelhead ESU in particular, dams in the Russian River are among the main factors affecting the ESU. Water diversions directly entrain fish, and can affect habitat by reducing wetted area and causing water temperatures to increase. Runoff from agricultural, urban, and other sources contains pollutants and suspended sediment, which affect water quality. Hatchery fish can compromise the genetic integrity of wild stocks, and fishing pressure on wild stocks can increase during years of high hatchery production. Habitat restoration projects can temporarily cause disturbance and increased suspended sediment in waterways, but ultimately may increase habitat abundance and complexity, stabilize channels and streambanks, increase spawning gravels, decrease sedimentation, and increase shade and cover for salmonids. Cycles in ocean productivity and drought conditions can have corresponding effects on salmonid life history parameters such as growth, recruitment, and mortality. Scientific research can lead to harm, harassment, and death of listed salmonids, but generally is thought to affect only a small number of fish in this manner. The knowledge gained from scientific research may lead to improved management of listed ESUs, increased population sizes, and consequently increased likelihood of survival and recovery.

The research activities described in this document do not result in any changes or effects to salmonid habitat including designated critical habitat for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, or Central California Coast steelhead. Therefore, critical habitat is not likely to be affected by issuance of Permit 1440 and is not considered further in this document.

B. Proposed Species

The issuance of Permit 1440 may potentially affect the Southern DPS of North American green sturgeon. This document describes the status of the proposed threatened Southern DPS of North American green sturgeon.

1. Species Life History, Population Dynamics, and Likelihood of Survival and Recovery

The Southern DPS of North American green sturgeon was proposed for listing on April 6, 2005 (70 FR 17386), and includes the North American green sturgeon population spawning in the Sacramento River basin and utilizing the Delta and Estuary. If the proposed listing is finalized, critical habitat will be designated and a recovery plan will be prepared and implemented for the Southern DPS of North American green sturgeon.

North American green sturgeon are widely distributed along the Pacific Coast and have been documented offshore from Ensenada Mexico to the Bering Sea and found only in rivers from British Columbia to the Sacramento River (Moyle 2002). As is the case for all sturgeon, North American green sturgeon are anadromous; however, they are the most marine-oriented of the sturgeon species (Moyle 2002). Based on sturgeon egg, larvae, and juvenile distribution in the Sacramento River, CDFG (2002) indicated that the Southern DPS of North American green sturgeon spawn in late-spring and early-summer above Hamilton City possibly to Keswick Dam. Spawning is thought to occur in deep turbulent pools of the Sacramento River mainstem. After approximately 10 days, larvae begin feeding; growing rapidly and young green sturgeon appear to rear for the first 1 to 2 months in the Sacramento River between Keswick Dam and Hamilton City (CDFG 2002). Juvenile sturgeon first appear in USFWS sampling efforts at Red Bluff Diversion Dam primarily during June and July at lengths ranging from 24 to 31 mm fork length

(CDFG 2002). Sampling efforts at Glen Colusa Irrigation District on the Sacramento River yield North American green sturgeon averaging approximately 29 mm with a peak in July (NMFS 2002b). Trawling studies in the Estuary and Delta since 1980 have taken a total of 61 juvenile sturgeon ranging in size from 20 to 112 cm total length and although most juveniles are captured between April and October, they have been captured nearly every month of the year (CDFG 2002, IEP Relational Database search May 31, 2005). Juveniles spend between 1 and 4 years in fresh and estuarine waters and enter the marine environment at lengths of approximately 300 mm (NMFS 2002b).

Population abundance information concerning the Southern DPS of North American green sturgeon is scant as described in the status review (NMFS 2002b). Limited population abundance information comes from incidental captures of North American green sturgeon from the white sturgeon monitoring program by the CDFG sturgeon tagging program (CDFG 2002). CDFG (2002) utilizes a multiple-census or Peterson mark-recapture method to estimate the legal population of white sturgeon captures in trammel nets. By comparing ratios of white sturgeon to green sturgeon captures, CDFG provides estimates of adult and sub-adult North American green sturgeon abundance. Estimated abundance between 1954 and 2001 ranged from 175 fish to more than 8,000 per year and averaged 1,509 fish per year. Unfortunately, there are many biases and errors associated with these data, and CDFG does not consider these estimates reliable. Fish monitoring efforts at Red Bluff Diversion Dam and Glen Colusa Irrigation District on the upper Sacramento River have captured between 0 and 2,068 juvenile North American green sturgeon per year, mostly between June and July (NMFS 2002b). The only existing information regarding changes in the abundance of the Southern DPS of North American green sturgeon includes changes in abundance at the John Skinner Fish Protection Facility between 1968 and 2001 (State facility). The average number of North American green sturgeon taken per year at the State Facility prior to 1986 was 732; from 1986 on, the average per year was 47 (70 FR 17386). For the Tracy Fish Collection Facility (Federal facility), the average number prior to 1986 was 889; from 1986 to 2001 the average was 32 (70 FR 17386). In light of the increased exports, particularly during the previous 10 years, it is clear that North American green sturgeon abundance is dropping. Catches of sub-adult and adult North American green sturgeon by the IEP between 1996 and 2004 ranged from 1 to 212 green sturgeon per year (212 occurred in 2001), however, the portion of the Southern DPS of North American green sturgeon is unknown as these captures were primarily located in San Pablo Bay which is known to consist of a mixture of the Northern and Southern population segments. Additional analysis of North American green and white sturgeon taken at the State and Federal facilities indicates that take of both North American green and white sturgeon per acre-foot of water exported has decreased substantially since the 1960's (70 FR 17386).

2. Habitat Condition and Function

The freshwater habitat of North American green sturgeon in the Sacramento-San Joaquin drainage varies in function, depending on location. Spawning areas are currently limited to accessible upstream reaches of the Sacramento River. There are historical reports of sturgeon spawning in the Feather River, but species distinctions (white vs. green) were not made (NMFS 2002b). Preferred spawning habitats are thought to contain large cobble in deep cool pools with

Turbulent water (CDFG 2002, Noyle 2002). Eggs are broadcast and externally fertilized in relatively fast water (Moyle 2002).

Migratory corridors are downstream of the spawning areas and include the mainstem Sacramento River and the Estuary and Delta. These corridors allow the upstream passage of adults and the downstream emigration of outmigrant juveniles. Migratory habitat condition is strongly affected By the presence of barriers which can include dams, unscreened or poorly screened diversions, and degraded water quality. Both spawning areas and migratory corridors comprise rearing habitat for juveniles, which feed and grow before and during their 1 to 4 year residence in freshwater. Rearing habitat condition and function may be affected by variation in annual and seasonal flow and temperature characteristics.

3. <u>Factors Affecting the Species and Critical Habitat</u>

The principal inland factors for decline in the Southern DPS of North American green sturgeon are reviewed in the proposed listing notice (70 FR 17386) and status reviews (NMFS 2002b, NMFS 2005), and primarily consist of harvest, impassible barriers, adult migration barriers, insufficient flow, increased temperatures, and water diversions. Ocean and estuarine harvest of the Southern DPS of North American green sturgeon is considered a species-wide threat as both Southern and Northern DPS populations are captured as a result of white sturgeon and salmonid fishing (NMFS 2005). Recent genetic and population information indicates catches in San Pablo Bay could be fish that originated in the Northern DPS. The impassible barriers, primarily Keswick and Shasta Dams likely block and prevent access to spawning habitat. Adult migration barriers such as the Red Bluff Diversion Dam, Sacramento Deep Water Ship Channel locks, Fremont Weir, Sutter Bypass, and the Delta Cross Channel Gates also pose threats to the North American green sturgeon as they prevent or delay upstream migration (70 FR 17386). The high number and density of unscreened and screened agricultural and municipal water diversions likely increase stress levels, injury, and harassment of North American green sturgeon and also contribute toward altered hydrology patterns and increased temperatures. Other Potential factors posing risk to the Southern DPS include non-native species interactions, poaching, pesticides and heavy metals, and local fishing pressure.

IV. ENVIRONMENTAL BASELINE

The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process (50 CFR §402.02). A detailed discussion of the factors affecting the salmonid ESUs in the Central Valley is provided in the Central Valley Research Opinion.

A. Status of the Species in the Action Area

1. Listed Species

The action area provides migratory habitat for listed salmonids in the Central Valley. Adult Sacramento River winter-run Chinook salmon typically migrate through the Estuary and Delta from November through July to their spawning grounds in the upper Sacramento River (USFWS 1995), while adult Central Valley spring-run Chinook salmon typically pass through the Estuary as they return to spawn in their natal tributaries in the Sacramento basin between March and September (USFWS 1995). Adult Central Valley steelhead likely pass through the Estuary and Delta prior to their migration through the Sacramento River and Feather River confluence between July and March (McEwan 2001). Adult Central California Coast steelhead exhibit typical winter-run life history patterns and likely pass through the Estuary prior to their migration to tributaries that drain into San Francisco, San Pablo, and Suisun Bays during the late-fall and winter (Leidy 2000).

Juvenile Sacramento River winter-run Chinook salmon pass through the action area during their emigration to the ocean from December through April (USFWS 1995). Juvenile spring-run Chinook salmon pass through the action area from October through May (USFWS 1995). Juvenile migrating Central Valley steelhead smolts are captured exiting the Delta primarily between January and May (Nobriga and Cadrett 2001, McEwan 2001), and the migration timing of juvenile Central California Coast steelhead likely is similar.

2. Proposed Species

The action area of Permit 1440 encompasses nearly the entire inland range of the Southern DPS of North American green sturgeon. The Southern DPS of North American green sturgeon utilizes the mainstem Sacramento River downstream of Knights Landing (the upper extent of the action area) as an adult migration corridor and juvenile migration and rearing corridor. The entire spawning population must therefore primarily pass the Knights Landing location to reach spawning grounds. The Southern DPS of North American green sturgeon also use the Delta and Estuary as a juvenile rearing and migration corridor and as an adult migration and feeding corridor as well. The portion of the North American green sturgeon population utilizing the interior Delta (as opposed to the mainstem Sacramento River) is unknown; however, it is thought to be comprised of a fraction of the Southern DPS population. Because the action area encompasses a substantial portion of the Southern DPS population, the status of the species in the action area is considered analogous to the current inland population range of the Southern DPS of North American green sturgeon.

B. Factors Affecting the Species in the Action Area

1. Listed Species

The Central Valley Research Opinion describes the ongoing activities and historical events that have affected listed salmonids in the Central Valley. Water diversion operations, fish passage through water quality control gates, dredging and mining operations, and hatchery operations are among the activities that have the largest potential impacts to the populations of listed salmonids in the action area. For example, the Central Valley Project and State Water Project pumps alter historical flow volume and patterns that affect the timing of juvenile outmigration and direction of adult upstream migration of salmonids. The Suisun Marsh Salinity Control Gates affect the timing and behavior of fish passing through Suisun Marsh, as well as increase the likelihood of fish predation on migrating salmonids. Dredging and sand mining projects affect habitat quality by degrading water quality, destroying vegetative cover, and temporarily disturbing fish. Finally, the large numbers of salmonid fish released from hatcheries (such as the Feather River and Mokelumne River hatcheries) can pose a threat to wild salmonids through genetic impacts such as inbreeding, and the increased competition, predation, and fishing pressure that may result from hatchery production. In addition to the factors mentioned above, urbanization and poor land-use practices also are among the major factors affecting Central California Coast steelhead in San Francisco, San Pablo, and Suisun Bays.

2. Proposed Species

The majority of watersheds contributing to the Estuary and Delta are now highly regulated and contain substantially different outflow patterns than they did historically. The magnitude and duration of base and peak flows have been altered affecting the temporal flow patterns North American green sturgeon has experienced over evolutionary time, and these changes in outflow patterns and magnitude and the effects of water diversions such as the Federal and State facility water pumps are thought be a principal threat to the species in the action area. CDFG (1992) found significant correlations between mean daily flow during the spring and white sturgeon year class strength, as well as spring outflow and annual production of white sturgeon indicating the importance of outflow for sturgeon production (these studies primarily involve the more abundant white sturgeon; however, the threats to North American green sturgeon are thought to be similar). In addition, Herren and Kawasaki (2001) catalogued 2,209 water diversion structures in the Delta area, of which only 1 percent were screened. Six percent of the 424 diversions catalogued on the Sacramento River between Keswick Dam and the I Street Bridge were screened. The effects of such diversions are largely unknown but thought to be substantial based on the number of diversions, total amount of water diverted, and the susceptibility of North American green sturgeon young to them (70 FR 17386). Increased temperature as a result of decreased outflow, reduced riparian shading, and by thermal inputs from municipal, industrial, and agricultural inputs in the Estuary and Delta also are considered a threat. Pollution within the Sacramento River increased substantially in the mid-1970s when application of rice pesticides increased (USFWS 1995). Increased urban and commercial development in the Estuary and Delta including along the mainstem Sacramento River results in additional water withdrawals and effluent containing pesticides, heavy metals, and organics in high levels (Central Valley Regional Water Quality Control Board 1998). Sturgeon also may accumulate polychlorinated biphenyls and selenium, substances known to be detrimental to embryonic development. Concerns also exist regarding the impacts of exotic species on the diet and predation of North American green sturgeon. The exotic overbite clam *Potamocorbula amurensis*, introduced in 1988, has become the most common food of white sturgeon and was found in the only North American green sturgeon so far examined by CDFG (2002). The overbite clam, which may be a

North American green sturgeon prey item, is known to bioaccumulate selenium, a toxic metal (CDFG 2002). North American green sturgeon also may experience predation by introduced species including striped bass. Sturgeon have high vulnerability to fisheries and the trophy status of large white sturgeon makes these fishes a high priority for enforcement to protect against poaching (CDFG 2002).

V. EFFECTS OF THE PROPOSED ACTION

The purpose of this section is to identify effects on listed Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, Central California Coast steelhead, and proposed threatened Southern DPS of North American green sturgeon associated with NMFS' issuance of Permit 1440.

A. Collection Gear Specific Effects

1. Listed Species

The potential effects of the proposed research activities on listed salmonids are anticipated to be limited because listed salmonids will not be explicitly targeted for capture. The analysis of potential effects to each ESU considers the species exposure and response to various project effects related to aspects such as project duration (*e.g.*, long-term vs. short-term), time of year in which sampling occurs, sampling location (*e.g.*, localized vs. widespread), life stage affected (*e.g.*, adults vs. juveniles), and lethality of activities (*e.g.*, ratio of lethal to nonlethal activities, and possible long-term effects of sampling activities).

Both long-term and short-term projects generally will affect more juvenile fish than adult fish. The larger effects to the juvenile population, in terms of numbers of juveniles subjected to project activities compared to adults, will result in a lower impact to the local population or ESU because individual adult fish have a higher contribution to the cohort replacement rate than individual juvenile fish. In particular, adult fish that return to freshwater have survived the risks during their freshwater and ocean residence (*e.g.*, predation, competition, water diversions, *etc.*) that outmigrating juvenile fish have yet to face and their abundance is considerably lower. For example, Emmett *et al.* (1997) estimated a general juvenile Chinook salmon survival in freshwater to be between 5 and 25 percent and ocean survival to be between 1 and 10 percent. Thus, overall survival of juveniles to adult would range from 0.05 percent to 2.5 percent ($5\% * 1\% = 0.05\%$, $25\% * 10\% = 2.5\%$) and the abundance of juveniles in freshwater to maintain a cohort replacement of 1.0 with a population level of 10,000 spawners would range between 4 million and 20 million ($10{,}000/.0025 = 4$ million, $10{,}000/0.0005 = 20$ million) juveniles. Gaines and Poytress (2004) estimated the juvenile population of Sacramento River winter-run Chinook salmon exiting the upper Sacramento River at Red Bluff Diversion Dam to be 3,707,916 juveniles per year using the JPI method between the years 1995 and 2003 (excluding 2000 and 2001) and 3,857,036 juveniles exiting the supper Sacramento River at Red Bluff Diversion Dam between the years of 1996 and 2003 using the JPE method. Although juvenile production data are not available for Central Valley spring-run Chinook salmon and Central Valley steelhead, relative survival rates of these species are believed to be similar to those of Sacramento River winter-run Chinook salmon. The impacts of the proposed monitoring program on juvenile abundance could affect the cohort replacement rate by decreasing the contributing juvenile portion of the population.

The primary impacts of both the long-term and short-term projects on individual listed salmonids are expected to be nonlethal in nature (Figures 4 and 5). The effects from nonlethal take are expected to be stress caused by capturing and handling fish, which are discussed in the Central Valley Research Opinion (NMFS 2003a), Northern and Central Coast Research Opinion (NMFS 2002a), and in more detail below. Because the majority of the projects do not directly target listed salmonids, the effects to any captured salmonid likely will result from stress associated with handling while releasing the fish. The effects of various sampling gears on listed salmonids were discussed in the Central Valley Research Opinion (NMFS 2003a) and Northern and Central Coast Research Opinion (NMFS 2002a). Therefore, this biological and conference opinion primarily addresses the potential exposure of listed salmonids to the IEP research activities due to the temporal and spatial overlap of the activities with fish presence. It should be noted that relatively few listed fish will be exposed to the adverse effects described below. The requested lethal and nonlethal take of each listed species for each project is identified in Table 2.

a. Project 1, Adult Striped Bass Population Parameters

Project 1, "Adult striped bass population parameters," utilizes a variety of methods to estimate the population dynamics of striped bass that include gill and trammel nets, hook and line sampling, and fyke nets. Though all sampling gears target striped bass, adult salmonids will be exposed to all of these gears and have been taken in past sampling efforts (Figure 8a). No juvenile salmonids have been taken by this project. The effects of capture by gill and fyke nets as well as hook-and-line and anchored gill nets are described below.

(1) *Gill and Fyke Nets.* Gill nets are employed 5 days per week between April 1 and July 15 in the western Delta, and fyke nets are employed at Knights Landing (Sacramento River) up to 7 days per week between March 15 and July 15. Gill and fyke netting activities occur during the majority of the spawning migration of Sacramento River winter-run Chinook salmon and therefore will affect winter-run adults more than other listed salmonids (Figure 7). Though Central Valley steelhead have been known to occur in the western Delta during April through July, they are not relatively abundant, and Central Valley spring-run Chinook salmon primarily migrate through the Sacramento River during the fall.

Gill nets are walls of netting suspended vertically in the water by a float line on the top and lead line on the bottom. The mesh of gill nets is relatively large and as fish attempt to pass through the mesh they are captured. Fish are captured by being gilled, wedged, or tangled. Gill nets used in project 1 contain enlarged mesh of variable sizes promoting entanglement rather than captures by gill. The effects of gill net captures varies depending on the entanglement type and ranges from little physical harm to physical injury related to excessive handling, and death due to suffocation. Capture can result in disrupted migration rates, feeding opportunities, and sheltering behavior leading to reduced health, predator avoidance, and ability to compete for resources.

These effects can result in delayed mortality and or reduced spawning success of adult fish. Sometimes fish are injured while being removed from a gill net, including damage to internal organs from being squeezed, damage to scales and mucus, and damage to jaws and other protruding segments of the body (NMFS 2003a). Physical injury and stress as a result of gill net sampling also can cause increased energy expenditures, possibly decrease feeding or growth rates, and increase the likelihood of predation. Based on the high qualifications of the research biologists and the low mortality expected, these migratory delays and the potential for physical injuries are assumed to be minimized as much as possible.

The fyke nets (also known as hoop nets) used in adult striped bass population parameter studies are cylindrical traps measuring 10 feet in diameter and 20 feet long, and contained by a series of internal funnel shaped throats that are directed inward from the mouth. The throats direct and trap the fish in the back end of the trap. Adult salmonid mortality resulting from fyke netting is generally low and the majority of effects of capture are minor. Capture can result in disrupted migration rates, feeding opportunities, and sheltering behavior leading to reduced health, predator avoidance, and ability to compete for resources. These effects can result in delayed mortality and or reduced spawning success of adult fish. Fish can also be injured in fyke traps if they get stuck in the trap mesh or while being captured from the live well with a dip net. In addition, damage to internal organs from being squeezed, damage to scales and mucus, and damage to jaws and other protruding segments of the body is also know to occur (NMFS 2003a).

Application materials received from the project applicant identified take of adult Chinook salmon but did not distinguish race (modification of permit application request from IEP, February 10, 2005). Gill and fyke net captures during the 1998, 2000, 2002, 2003, and 2004 field seasons primarily occurred during April, May and June coinciding with the peak adult Sacramento River winter-run Chinook salmon migration season. With similar efforts between years, adult captures ranged from between 8 and 70 Chinook salmon per year; mortality ranged between 0 and 50 percent (Figure 8a). A total of 15 Central Valley steelhead were captured in these efforts with 2 mortalities in the 2000, 2002, 2003, and 2004 field seasons combined (Figure 8a).

(2) ***Hook-and-Line and Anchored Gill Nets.*** Hook-and-line and anchored gill netting occurring in Clifton Court Forebay (CCF) between February and November are not expected to result in capture of adult salmonids as CCF is outside the typical migratory pathway of adults.

b. *Project 2, Fall Midwater Trawl*

Project 2, "Fall midwater trawl," utilizes a midwater trawl between September and December in the action area targeting juvenile fishes and overlapping with a portion of the Sacramento River winter-run Chinook salmon upstream migration period (Figure 7). These trawling efforts are not expected to capture a substantial number of adult salmon as the slow trawling speeds and small mesh size of the gear targets juvenile fish. Because of the wide variety of life history strategies of Central Valley and Central California Coast steelhead, juveniles of these fish could be exposed to the trawling gear. A portion of the juvenile Sacramento River winter-run Chinook salmon are exposed to these activities during migration to the ocean.

The effects to fish captured by nets are reviewed in the Central Valley Research Opinion (NMFS 2003a) and may result in abrasion to fish scales and dermal mucus, gilling, suffocation, crowding, in-net predation, and crushing from handling and debris. Variables such as water and air temperatures, fish condition, net mesh size and material also can influence whether captured fish are returned to water with low stress and no mortality. The response of juvenile salmonids to the effects of trawling range from disrupted migration rates, feeding opportunities, and sheltering behavior leading to reduced health, reduced ability to avoid predators, and reduced ability to compete for resources. Kelsch and Shields (1996) indicate the additional stress caused by handling of fish also can result in increased oxygen consumption, reduced capacity for activity, osmoregulation, problems of decreased growth, and decreased reproduction capacity. The resultant immediate or delayed mortality can reduce juvenile salmonid abundance decreasing the overall juvenile population which can affect recruitment. Because the nets used in Project 2, "Fall midwater trawl" are towed at slow speeds, are relatively small, and sampling is of short duration, mortality is expected to be low.

Yearly adult catch since 1998 has ranged from 0 to 6 Sacramento River winter-run Chinook salmon, 0 Central Valley spring-run, and 0 to 1 Central Valley or Central California Coast steelhead (Figure 8b). Juvenile Sacramento River winter-run Chinook salmon and Central Valley spring-run Chinook salmon captures ranged from 0 to 11 and 0 and 3 fish per field season, respectively. No juvenile or adult mortality in the fall midwater trawl has been observed since 1998.

c. *Project 3, Adult Sturgeon Tagging*

Adult Central Valley California Coast steelhead, Central Valley spring-run Chinook salmon, and Central Valley steelhead are potentially exposed to sturgeon tagging studies occurring between August and October with trammel nets in San Pablo Bay. Central California Coast steelhead and Central Valley spring-run Chinook salmon and steelhead exposure would occur for the duration of the sampling effort. The effects of trammel nets are thought to be similar to though less severe than those caused by gill nets and vary depending on the entanglement method. Effects are expected to range from little physical harm to excess stress on the fish and physical injury. Mild effects include disrupted migration rates, feeding opportunities, and sheltering behavior which can lead to reduced health and ability to evade predators, and the ability to compete for resources. Fish can also be injured during their capture by being squeezed, having their scales and mucous rubbed off, and by damage to fins and protruding body segments (NMFS 2002a; 2003a).

No Chinook salmon have been captured in this sampling effort since 1986 (Modification of permit application request from IEP, February 10, 2005). A total of 4 Central Valley steelhead were captured in sampling efforts since 1986, all 4 occurring in 2001, resulting in no mortality (Figure 8c).

d. *Project 4, Delta Resident Shoreline Fish Monitoring*

Project 4, "Delta resident shoreline fish monitoring," involves sampling monthly year-round at selected shoreline locations throughout the Delta using boat electrofishing methods. Electrofishing can result in a variety of effects from simple harassment to injury to the fish (adults and juveniles) and death. There are 2 major forms of injuries from electrofishing; hemorrhages in soft tissues and fractures in hard tissues. Electrofishing can also result in trauma to fish from stress (NMFS 2003a). Recovery from this stress can take up to several days, and during this time the fish are more vulnerable to predation, and less able to compete for resources. Stress-related deaths also can occur within minutes or hours of release, with respiratory failure usually the cause. Electrofishing can have severe effects on adult salmonids, particularly spinal injuries from forced muscle contraction. Studies also found dramatic negative effects of electrofishing on the survival of eggs from electroshocked female salmon (NMFS 2003a). The effects of electrofishing are further described in the Central Valley Research Opinion (NMFS 2003a).

Because of the spatial and temporal aspect of the electrofishing effort, both juvenile and adult salmonids can be exposed to the sampling; however, because this effort is completed along the shoreline, the probability of encountering adults is low. In addition, the study sites for electrofishing for resident fish in the Delta are not in the vicinity of adult salmonids in spawning condition or near redds. Juveniles are more likely to be exposed to the sampling activities, but the relatively few studies that have been conducted on juvenile salmonids indicate that spinal-injury rates are substantially lower than they are for large fish. Smaller fish intercept a smaller head-to-tail potential than larger fish (Sharber and Carothers 1988) and may therefore be subject to lower injury rates (*e.g.*, Hollender and Carline 1994, Dalbey *et al.* 1996, Thompson *et al.* 1997). McMichael *et al.* (1998) found a 5.1 percent injury rate for juvenile steelhead captured by electrofishing in the Yakima River sub basin.

One adult Central Valley steelhead and no listed Chinook salmon were captured as a result of electrofishing sampling efforts in 1999, 2001, 2002, and 2003. A total of 8 juvenile Sacramento River winter-run Chinook salmon were captured, one of which died (Figure 8d). During the same sampling period, a total of 35 juvenile Central Valley spring-run Chinook salmon were captured (10 in 2002, and 25 in 2003), and 10 juvenile Central Valley steelhead were captured with no mortality (Figure 8d).

e. *Project 5, Estuarine and Marine Fish Abundance and Distribution Survey*

Project 5, "Estuarine and marine fish abundance and distribution survey," uses midwater and otter trawls year-round between South San Francisco Bay and the Delta during all months of the year to sample for juvenile fishes, crabs, and shrimp. Adults and juveniles from all of the listed salmonid ESUs are expected to be exposed to this sampling because it occurs along active migration routes. Impacts to adults are expected to be low, as these gears are usually avoided by larger salmonids.

The effects to fish captured by nets may result in abrasion and removal of fish scales and dermal mucus, gilling, suffocation, crowding, in-net predation, and crushing from handling and debris. Variables such as water and air temperatures, fish condition, or net mesh size and material can influence the stress level and likelihood of mortality. The response of juvenile salmonids to the effects of trawling range from altered migration routes to increased disease susceptibility and immediate death. Because the nets used are towed at slow speeds, are relatively small, and sampling is of short duration, mortality is anticipated to be low.

Yearly sampling efforts between 1998 and 2004 resulted in 1 nonlethal incidental adult capture of Central Valley spring-run Chinook salmon in 1999, and 1 nonlethal Central Valley or California Coast steelhead (based on location of trawling, these 2 fish can not be distinguished from each other) in 1999. Between 0 and 12 Sacramento River winter-run Chinook salmon, 21 and 41 juvenile Central Valley spring-run Chinook salmon, and 0 and 3 Central Valley and/or Central California Coast steelhead have been captured per year. Mortality observed since 1998 has been relatively low, averaging less than 5 percent per year (Figure 8e). Because previous sampling efforts have resulted in low juvenile mortality and these projects will employ similar sampling protocols, it is expected that mortality will remain low.

f. Project 6, Delta Smelt 20-mm

Project 6, "Delta smelt 20-mm survey," involves sampling the San Pablo Bay and Eastern Delta with a plankton net every 14 days between March and August, overlapping with all listed juvenile salmonid migration periods; however, the projects using nets with small mesh sizes are not expected to capture juvenile salmonids, which are typically more susceptible to coarser-meshed gear towed at higher speeds. A 1600-micron mesh plankton net (fished for 10 minutes), which targets 20-mm delta smelt, has historically captured very few juvenile salmon, and resulted in no mortality (Figure 8f). Effects of this gear on listed salmonids are expected to be very low (*i.e.*, on the order of 0 to 2 captured juvenile salmonids per year).

g. Project 7, Real-time Monitoring

The real-time monitoring project addressed in this assessment includes Kodiak trawling between April and June on the San Joaquin River at Mossdale to capture juvenile fishes including Chinook salmon. The effects of Kodiak trawling are similar to otter and midwater trawling (see above) and can decrease fitness levels and reduce juvenile salmonid abundance and recruitment to the adult population. Because the nets used are towed at slow speeds, are relatively small, and sampling is of short duration, catch and mortality are expected to be relatively low.

Though a considerable number of Chinook salmon taken at the Mossdale trawl location have been classified as spring- and winter-run during previous years, the majority of these fish are thought to be San Joaquin River basin origin fall-/late fall-run Chinook salmon as only remnant populations of spring-run and no winter-run populations exist in the San Joaquin River basin. The only listed salmonids impacted by this effort are Central Valley steelhead and no adult salmonids have been captured in the real-time monitoring effort at Mossdale since 1998. Sampling efforts have captured between 1 and 20 juvenile Central Valley steelhead per year with no mortality (Figure 8g). Because previous sampling efforts have resulted in no juvenile mortality and these projects will employ similar sampling protocols, it is expected mortality of Central Valley steelhead as a result of this project will occur rarely (as in Figure 8g).

h. Project 8, Spring Kodiak Trawl Survey

Project 8, "The Spring Kodiak trawl survey," involves sampling a total of 6 days in February and March each year in the action area from the Napa River east to the lower Sacramento and San Joaquin Rivers potentially capturing juvenile Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley and Central California Coast steelhead. The effects of Kodiak trawling are similar to otter and midwater trawling (see above) and can range from abrasion and removal of fish scales and dermal mucus, gilling, suffocation, crowding, in-net predation, and crushing from handling and debris. Capture can result in disrupted migration rates and feeding opportunities and disrupted sheltering behavior leading to reduced health, predator avoidance, and ability to compete for resources. These effects can result in delayed mortality juvenile abundance. Because the nets used are towed at slow speeds, are relatively small, and sampling is of short duration, catch and mortality are expected to be relatively low.

Catches of juvenile Sacramento River winter-run Chinook salmon have ranged from 4 to 16 fish per field season and had mortality ranging from 0 to approximately 10 percent (Figure 8h). Relatively high take of juvenile Central Valley spring-run Chinook salmon occurred in 2003 (114) and 2004 (77); however, mortality during both years was less than 1 percent. Capture of juvenile Central Valley and Central California Coast steelhead ranged between 1 fish and 16 fish per season with no mortalities (Figure 8h).

i. Project 9, UC Davis Suisun Marsh Fish Monitoring

The UC Davis Suisun Marsh fish monitoring project involves sampling the sloughs within Suisun Marsh monthly using otter trawls and beach seines in an effort to monitor juvenile fish populations and habitat use. All listed salmonids could be exposed to this sampling as it occurs in habitat connected to Suisun Bay; however, the abundance of listed salmonids in Suisun Marsh is relatively low. Impacts to adults are expected to be low as well because they are expected to avoid these gears. Three juvenile steelhead were caught in 7 years of sampling (Figure 8i), and these may have been Central California Coast steelhead originating from Suisun Creek or other small streams that empty directly into Suisun Marsh. The effects of trawling on salmonids have been discussed previously. The effects of seining on juvenile salmonids range from behavior effects such as altered migration routes to physical damage related to the hauling, collecting, and handling of the fish and death caused by being crushed or left in the seine after sampling. In general, salmonids fare better in beach seine captures than trawls as trawl pressure and debris loads are higher than seines and fish are often returned to the water faster than in trawling operations.

j. Project 10, South Delta Temporary Barriers Fish Monitoring

Modified fyke nets are attached to the ends of culverts at the Head of Old River Barrier on the San Joaquin River between April and May during juvenile non-listed fall/late-fall-run Chinook salmon smolt migration periods. Based on the restricted time window in which the fyke nets are used and the Head of Old Barrier is installed, there is a low likelihood of capturing adult or juvenile listed salmonids. Water velocity and debris loads tend to vary considerably through the culverts and are a function of flows and culvert placement. Juvenile Chinook salmon mortality can be high.

Sampling efforts between 1998 and 2002 yielded a total of 23 juvenile spring-run Chinook salmon, all during the 2001 sampling season and resulting in mortality exceeding 95% (Figure 8j). Though these salmon were categorized as spring-run Chinook salmon, they are likely fall/late-fall-run Chinook salmon as spring-run fish are not present in the San Joaquin basin and previous sampling efforts have identified relatively large fall/late-fall-run Chinook salmon there. Thus, the potential effects of South Delta Barrier monitoring on spring-run Chinook salmon and other listed salmonids are believed to be very low. A total of 3 winter-run sized Chinook salmon were captured in 1999 with no mortality and no Central Valley steelhead were captured during sampling efforts between 1998 and 2004 (Figure 8j).

k. Project 11, Yolo Bypass Fish Monitoring

The Yolo Bypass Fish Monitoring study is a short-term program expiring in 2006. Gears used include larval fish and drift nets, fyke nets, rotary screw traps, and beach seines. Because of the variety of gears and location of Yolo Bypass sampling activities, both juvenile and adult Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead will be exposed to sampling activities. The effects of specific gears are described below.

(1) ***Larval Fish and Drift Nets.*** Zooplankton and insect drift samples will be taken from fixed nets attached to rotary screw traps in the Yolo Bypass and on boat docks at Sherwood Harbor on the Sacramento River. Nets are fished for 30 minutes during morning hours at Sherwood Harbor, and in the bypass, monthly during ebb tides during dry or unflooded conditions and weekly when the bypass is flooded for a yearly total of 20 pairs. Zooplankton and insect drift nets are not likely to adversely affect listed salmonids because both juveniles and adults are expected to successfully avoid these small, slow moving nets.

(2) ***Fyke Traps.*** The fyke trap, similar to the traps used for the "Adult striped bass population parameters monitoring," will be fished 7 days per week between October and June in the Toe Drain of the Yolo Bypass and target adult salmon. Because trapping will occur during a significant portion of the upstream migration period of Sacramento River winter-run Chinook salmon, as well as Central Valley spring-run Chinook salmon and Central Valley steelhead, adult captures of listed fish are expected, although the Yolo Bypass is not considered a primary migration route for adults. The live well of the trap will be lined with ¾ inch square plastic mesh to improve collection and protection of Sacramento splittail. The use of ¾ inch mesh will protect

smaller salmonids such as Central Valley steelhead from getting wedged between meshes of the fencing material.

Efforts during 2000, 2001, and 2002 yielded a total of 4 winter-run Chinook salmon adults, 9 spring-run Chinook salmon adults, and 2 Central Valley steelhead adults (Figure 8k). Adult salmonid mortality resulting from fyke netting is generally low and the majority of effects of capture are minor. Capture can result in disrupted migration rates, feeding opportunities, and sheltering behavior, leading to reduced health, predator avoidance, and the ability to compete for resources. These effects can result in delayed mortality and or reduced spawning success of adult fish. Fish can also be injured in fyke traps if they get stuck in the trap mesh or while being captured from the live well with a dip net. In addition, damage to internal organs from being squeezed, damage to scales and mucus, and damage to jaws and other protruding segments of the body is also know to occur (NMFS 2003a). Future adult salmonid injury and mortality resulting from fyke netting is expected to be low. All captures to date of listed salmonids in fyke nets has been nonlethal.

(3) ***Rotary Screw Traps and Beach Seines.*** An 8-foot rotary screw trap will be operated in the Toe Drain up to 7 days a week between January and June during ebb tides. Captures of juvenile Sacramento River winter-run Chinook salmon and Central Valley spring-run Chinook salmon are expected as trapping operations occur during downstream migration seasons. In most cases, juvenile salmonids captured in rotary screw traps are released unharmed; however, fish can experience stress and injury from overcrowding, and debris buildup can kill or injure fish if the traps are not emptied on a frequent basis. Fish captured in traps also are vulnerable to in-trap predation by other fish and mammals. Beach seining will be conducted biweekly during periods when the Yolo Bypass floodplain is inundated, at 2 to 5 established sites located around the perimeter of the Yolo Bypass. During dry years when inundation does not occur, beach seining will be conducted monthly at 3 reference stations. Beach seining can affect juvenile fish behavior by causing them to alter their migration routes or sheltering or feeding patterns, or may cause physical damage related to the hauling, collecting, and handling of the fish and potential death caused by being crushed or left in the seine after sampling.

Capture of juvenile winter-run Chinook salmon ranged from 0 to 14 fish per year between 1999 and 2002 and resulted in mortality between 0 and 14 percent. Capture of juvenile spring-run Chinook salmon ranged from 0 fish to 430 fish per year between 2000 and 2002 resulting in a lethal capture of less than 1 percent (Figure 8l). Because of the fast growth rates experienced by salmonids in the Yolo bypass, many of these spring-run size fish may be fall/late-fall-run Chinook salmon. Capture of Central Valley steelhead was all nonlethal and ranged from 1 to 29 juveniles per year between 1998 and 2004. Capture in the future is expected to be mostly comprised of spring-run sized Chinook salmon and highly variable due to Yolo Bypass inundation frequencies, and mortality is expected to continue to be low.

l. Project 12, Diagnostic Indicators of Salvaged Delta Smelt

Sampling is conducted using a purse seine from Montezuma Slough in Suisun Bay east to Decker Island near the lower Sacramento River between October and December. Between 2 and

12, 15-minute sets are conducted per day from 3 to 4 days per week. Listed adult salmonids are not expected to be captured in the purse seine because they are expected to successfully avoid the net due to its slow deployment and small size. Juvenile salmonid captures are expected to be related to exposure due to migration timing, and therefore mostly comprised of winter-run Chinook salmon as sampling occurs during the smolt migration season. A relatively small number of spring-run Chinook salmon fry also are expected to be exposed to this sampling effort. Juvenile Central Valley steelhead are not likely to be captured in purse seine activities as they are commonly larger when encountered in the action area and able to evade the net. The effects of purse seining to juvenile salmonids captured by nets may result in abrasion of fish scales and dermal mucus, gilling, suffocation, crowding, in-net predation, and crushing from handling and debris. Variables such as water and air temperatures, fish condition, and net mesh size or material also can influence whether captured fish are returned to water with low stress and no mortality. The response of juvenile salmonids to the effects of trawling includes altered migration routes, physical injury, increased disease susceptibility, or immediate death. Immediate or delayed mortality may reduce juvenile salmonid abundance as a result of these effects, and may reduce overall recruitment to the adult population. Sampling for this element started in 2004 and no listed salmonids were recovered. This result may reflect low exposure of juveniles to the purse seine due to the brief set times, or the ability of juveniles as well as adults to avoid the slowly-deployed net.

m. Project 13, Determining the Occurrence and Magnitude of Predation in the Collection, Handling, and Transport Process at the Federal and State Fish Facilities

The study titled "Determining the occurrence and magnitude of predation in the collection, handling, and transport process at the Federal and State fish facilities" is a 3-year project that utilizes delta smelt already salvaged by the Federal and State facility water pumps between December and May. Salmonids captured as a result of this project have already been salvaged at the pumping plants and additional effects of the project are associated with additional project related handling. The study could expose some salvaged fish to additional stress, injury, and possible predation due to further handling. Salvaged fish will be placed into a large tank or swimming pool and removed by hand nets. The extent of injury may vary depending on the fish species, life-stage, size, and seasonal entrainment conditions. The additional handling as a result of the study also could delay and/or further alter the migratory behavior of listed salmonids. The responses of such effects include decreased health, energy, and the ability to compete for resources and avoid predators. In addition, reduced juvenile salmonid abundance can have negative effects on the cohort replacement rate. Pilot efforts during 2004 did not capture any listed salmonids, although effort was relatively low.

n. Project 14, Acute Mortality and Injury Rates of Delta Smelt During High Entrainment Periods

Project 14, "Acute mortality and injury rates of delta smelt during high entrainment periods" involves collecting delta smelt using a purse seine from Montezuma Slough in Suisun Bay east to Decker Island near the lower Sacramento River from May through July, and from December through March. Between 2 and 12, 15-minute sets are conducted per day from 3 to 4 days per week. The effects of purse seine activities were discussed in the project titled "Diagnostic indicators of salvaged delta smelt." The small size of the net and slow deployment should enable adult salmonids to avoid capture. Juvenile salmonid capture is expected to be mostly comprised of fry and juvenile winter- and spring-run Chinook salmon as sampling occurs during the juvenile migration season. Juvenile Central Valley steelhead are not likely to be captured in purse seine activities because of their larger size when they pass through the action area, and increased ability to avoid capture. Sampling for this element started in 2004 and no listed salmonids were recovered.

o. Project 15, Morrow Island Distribution System Diversion Evaluation

Project 15, "Morrow Island distribution system diversion evaluation study" involves the use of purse seines, fyke nets, and beach seines in Goodyear Slough in Suisun Marsh approximately 1 day per week between September and May to monitor listed species vulnerable to diversions. Sampling will be conducted during higher tides within tidal cycles and will coincide with opening of agricultural canals. In addition, modified nets will be placed on Morrow Island agricultural diversions, and water entering agricultural canals will be sampled in 1 of the 3 agricultural diversions. If listed fish are found to be present in Goodyear Slough, additional sampling at the agricultural canal diversions will be implemented. All listed salmonids could be exposed to this sampling as it occurs in habitat connected to Suisun Bay; however, abundance of salmonids in Suisun Marsh is relatively low. In addition, impacts to adults are expected to be low as purse seines and beach seines are designed for sampling juvenile fishes and are avoidable by larger salmonids. Listed salmonids captured in the fyke traps on diversion canals likely would be lost to agricultural diversions. Monthly sampling efforts with an otter trawl in Goodyear slough since 1979 have captured 2 Chinook salmon and have never captured California Coast steelhead or Central Valley steelhead (Project 9, UC Davis Suisun Marsh Fish Monitoring).

2. <u>Proposed Species</u>

The vast majority of nonlethal effects and approximately half of the lethal effects on North American green sturgeon would primarily occur from the adult sturgeon tagging program. Nonlethal capture of North American green sturgeon also occurs in both long and short-term studies and approximately half the mortality is associated with "Adult striped bass population parameters monitoring" and "Estuarine and marine fish abundance" studies. NMFS considers how capture of proposed listed North American green sturgeon incurred by the project will jeopardize the continued existence of the Southern DPS. In assessing the effects of the proposed project on the Southern DPS, NMFS considers the species exposure and response to various project effects related to aspects such as project duration (*e.g.*, long-term vs. short-term), time of year in which sampling occurs, sampling location (*e.g.*, localized vs. widespread), life stage subject to sampling activities (*e.g.*, adults vs. juveniles), and mortalities (*e.g.*, ratio of lethal to nonlethal activities, and possible long-term effects of sampling activities).

a. Project 1, Adult Striped Bass Population Parameters

Project 1, "Adult striped bass population parameters," utilizes gill and trammel nets, hook and line sampling, and fyke nets to estimate the population dynamics of striped bass. Though all these sampling gears target striped bass, North American green sturgeon are exposed to gill netting occurring in the lower Sacramento and San Joaquin rivers and fyke netting at Knights Landing on the Sacramento River. Therefore, this assessment only analyzes the effects of the gill and fyke net portion of the adult striped bass population parameter studies.

Effort and logistics of gill nets, which are employed 5 days per week between April 1 and July 15 in the western Delta and fyke nets which are employed at Knights Landing (Sacramento River) up to 7 days per week between March 15 and July 15 for striped bass analysis have been discussed previously in the effects to listed species section of this opinion. Both of these activities overlap with typical North American green sturgeon presence in the Estuary and Delta and mainstem Sacramento River (Figure 7).

Gill net set times have been changed from approximately 40 minutes to 20 minutes in recent years to reduce salmonid impacts. The effects of gill netting vary depending on the entanglement method and range from little physical harm resulting in disrupted migratory, feeding, and sheltering patterns, stress resulting in altered metabolic state, to physical injury related to excessive handling, and potentially death due to suffocation and exhaustion. These effects can result in delayed mortality and or reduced spawning success of adult fish. Behavioral delays and physical injury as a result of capture is likely not significant due to the short set times.

Most of the effects of fyke net captures on North American green sturgeon occurred when the fyke nets were pulled toward the surface and the fish were removed from the live well; however, protocols in recent years have been changed and this situation no longer occurs (Marty Gingras, CDFG, personal communication, May 26, 2005). It is assumed adult North American green sturgeon fyke net captures primarily are potential spawners en route to the upper Sacramento River where spawning is thought to occur during the late spring and early summer. Effects of fyke net captures range from disrupted behavioral patterns, to physical injury related to excessive handling potentially leading to death, though this is thought to be rare as records provided by the applicants indicate no observed mortalities since sampling in 1974. Additional details regarding these types of effects are described in section *b* below and in the *Integration and Synthesis* section of this opinion.

North American green sturgeon captures between 1998 and 2004 has ranged from 0 to 2 fish per year (Figure 9). Fyke traps have captured a total of 6 North American green sturgeon during 5 different years between 1974 and 2000 (CDFG 2002). Two of these captures occurred when the fyke traps were moved from Knights Landing to Clarksburg, approximately fifty miles downstream (CDFG 2002). The majority of North American green sturgeon captures occur in April (CDFG (2002).

b. Project 3, Adult Sturgeon Tagging

The adult sturgeon tagging project is the only IEP project designed to estimate sturgeon population parameters, and hence captures the most North American green sturgeon. North American green and white sturgeon are captured with trammel nets in San Pablo Bay from August through October during 2-year alternating sampling periods (*i.e.*, 2 field seasons on, 2 field seasons off). Sturgeon are captured in trammel nets, brought onto the boat, tagged with disk angler reward tags, and released immediately. The effects of trammel netting range from little physical harm resulting in short-term disruptions of migratory, sheltering, and feeding behaviors, stress resulting in altered metabolic state, to physical injury related to excessive handling, and potential death due to suffocation and exhaustion. Recent research by Lankford *et al.* (2005) found that exposing North American green sturgeon to physical stressors such as being chased by nets or confinement in holding tanks resulted in elevated "maintenance" metabolic rates and decreased capability of the fish to deal with additional energy demands. Captures in the trammel nets generally are brief and relatively benign relative to other capture techniques such as angling and there is no evidence that this type of stress is long-term or jeopardizes the overall health of the fish, including reproductive potential.

Yearly captures of North American green sturgeon in the sturgeon tagging program in September and October range from a total of 14 fish per year to 208 (Figure 9). CDFG (2002) indicates a total of 233 North American green sturgeon have been tagged in San Pablo Bay between 1954 and 2001 (averaging less than 5 fish per year).

c. Project 5, Estuarine and Marine Fish Abundance and Distribution Survey

The occurrence of monthly midwater and otter trawling in the action area as a result of project 5 exposes juvenile North American green sturgeon to potential capture primarily in Carquinez Strait upstream to the Delta (CDFG 2002). The primary effects of midwater and otter trawl on fish have been discussed previously in this opinion and will not be repeated here, but include the disruption of migratory, feeding, and sheltering behaviors, physical injury or death.

Yearly catch of North American green sturgeon sampling efforts between 1998 and 2004 in project 5 ranged from no fish captured per year to a total of 6 (Figure 9). CDFG (2002) reports a total of 61 juvenile captures between 1980 and 2001, primarily in the Carquinez Strait and secondarily in San Pablo Bay and San Francisco Bay. The majority of North American green sturgeon were captured between April and October.

d. Project 11, Yolo Bypass Fish Monitoring

As part of project 11, fyke traps will be fished 7 days per week between October and June in the Toe Drain of the Yolo Bypass in an effort to capture various species of adult fish. Because trapping will occur during the upstream migration period of adults and downstream migration of juveniles, North American green sturgeon present in the Yolo Bypass could be exposed to capture by the sampling activities. Because the Yolo Bypass is not part of the main migration corridor of juvenile or adult North American green sturgeon, and because it is only flooded during wet water year types, only a small portion of the population is expected to be present and exposed to trapping. Efforts from 2000 to 2004 did not capture any North American green sturgeon in the Toe Drain.

B. Beneficial Effects of Issuing Research Permit 1440

NMFS supports IEP's projects on the basis of IEP's goal to collect and provide information on the ecology of the Estuary and Delta and the effects of the State and Federal Water Projects, which is meant to help with the management of resources in the Estuary, including the Delta. The use of ESA-listed species for scientific research is consistent with the purpose of the ESA when the research facilitates recovery of a listed species. Scientific information is necessary to reduce uncertainty when: determining whether a consultation is to be conducted formally or informally; determining whether an action jeopardizes a listed species; and when developing terms and conditions, reasonable and prudent measures, or alternatives. In order to facilitate the restoration and recovery of listed salmonids within the Central Valley of California, scientific research programs directed toward developing a more robust and complete body of information are needed. Resulting information from this research project is valuable to reduce uncertainty in management decisions that might affect salmonids. Also, monitoring activities can help NMFS determine if protective actions are assisting in the recovery of listed species within the action area. Information from research activities can facilitate recovery. The impacts to populations within the ESUs are not expected to be sufficient to reduce appreciably the likelihood of survival and recovery of them.

The IEP sturgeon tagging program is the only known sturgeon-based monitoring program in the Central Valley. Information obtained from this monitoring program has already been used in determining population trends and distribution information as well as critical life-history aspects of the North American green sturgeon population. Continued sampling is needed to monitor population trends for ESA-related uses.

VI. CUMULATIVE EFFECTS

Cumulative effects are defined in 50 CFR § 402.02 as "those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation." Future Federal actions, including the ongoing operation of hatcheries, water diversions, and some land management activities, will be reviewed through separate section 7 consultation processes and not considered here. Similarly, non-Federal actions that require authorization under section 10 will be evaluated in separate section 7 consultations and not considered here. A general summary of potential cumulative effects that may affect Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and Central California Coast steelhead within the action area is provided in the Central Valley Research Opinion and in this document. In addition, potential cumulative effects that may affect the proposed Southern DPS of North American green sturgeon have been discussed in this document and the recent proposed listing and North American status reviews (70 FR 17386, NMFS 2002b, NMFS 2005). Potential cumulative impacts that may occur and affect listed species in the action area include ongoing agricultural and urban activities that likely will continue to affect stormwater runoff patterns and water quality in the action area, and future population growth that will result in new urban development and increased disturbance of waterways and riparian areas, as well as stormwater and water quality impacts.

VII. INTEGRATION AND SYNTHESIS

A. Listed Species

NMFS considers how take of listed salmonids incurred by the project will jeopardize the continued existence of each of the listed salmonid ESUs. Because an unknown portion of the nonlethal take will likely result in mortality, the effects of lethal and nonlethal take are considered in this analysis. The effects assessment analyzes the risks of the proposed research program to individual species within ESUs.

As indicated in the *Effects of the Proposed Action* section, relatively few listed salmonids are expected to be exposed to the adverse effects of the proposed monitoring program, and the effect of juvenile take has the potential to affect the cohort replacement rate of the population. A total lethal juvenile take of 18, representing 0.0005 percent of the estimated juvenile population and nonlethal take of 165 representing 0.0040 percent of the estimated juvenile population of Sacramento River winter-run Chinook salmon is expected. Thus, the effects of juvenile take to the Sacramento River winter-run Chinook salmon ESU would primarily result in a small change in the juvenile population size by removal of approximately 0.004 to 0.005 percent of the population. The small change in juvenile population will have a minor affect on the cohort replacement rate, as the number of juveniles contributing to the adult population will be decreased. Adult take, is expected to be 3 lethal, and 36 nonlethal (Table 2). Based on a mean population size of 5,614, this would represent approximately 0.05 percent and 0.64 percent of the adult population, respectively. Assuming a generous average fecundity of 5,000 eggs per female and a 1 percent egg to smolt survival rate, a loss of 3 adults has the potential to reduce the juvenile population by an average of 75 individuals (1.5 spawning females*5,000*.01 = 75) equaling approximately 0.002 percent of the following year's juvenile population based on JPI estimates. When adding these estimates to the lethal take of juveniles, the total juvenile take is expected to average 0.0025 percent of the juvenile population. Because expected lethal and nonlethal take of juvenile Sacramento River winter-run Chinook salmon represents a relatively small portion of the juvenile population of the ESU and is not expected to alter the growth rate significantly, and because the lethal and nonlethal take adults are a relatively small portion of the population, the proposed level of take is not expected to jeopardize the existence of the ESU.

Juvenile production estimates for Central Valley spring-run Chinook salmon are not available; however, the abundance of the juvenile population can be estimated using published Chinook salmon survival estimates (see *Effects of the Proposed Action* section). Expected lethal take of juvenile Central Valley spring run is 72, and expected nonlethal take is 950. Assuming an average population size of 12,499 adults, the average juvenile production required to maintain that population based on published survival estimates would be between 4,999,600 and

24,988,000 juveniles per year. Thus, the expected lethal take would remove between 0.0003 and 0.0014 percent of the juvenile population affecting the growth rate of the Central Valley spring-run Chinook salmon population. The nonlethal juvenile take would represent an impact to between 0.019 and 0.004 percent of the estimated adult population size. It should be noted that a significant portion of the Central Valley spring-run Chinook salmon juvenile take likely are fall/late-fall-run Chinook salmon. Past genetic analysis of spring-run sized Chinook salmon captured by the IEP program has revealed that a high percentage actually is fall/late-fall-run Chinook salmon. The high take of spring-run sized Chinook salmon in the Yolo Bypass likely reflects the enhanced growth rates experienced in such flooded habitat. Total nonlethal take of adults is 100 fish, and total lethal take is 10 representing 0.8 percent and 0.08 percent of the estimated population size of spring run between 1991 and 2003, respectively. Assuming an average fecundity of 5,000 eggs per female and a 1 percent egg to smolt survival rate, a loss of 10 adults has the potential to reduce the juvenile population by an average of 250 individuals (5 spawning females*5,000*.01 = 250) equaling between 0.001 and 0.005 percent of the following years juvenile population. When adding these estimates to the lethal take of juveniles reported above, the total juvenile take is expected to average between 0.0013 and 0.0064 percent of the juvenile population. Because expected lethal and nonlethal take of juvenile Central Valley spring-run Chinook salmon represents a relatively small portion of the juvenile population of the ESU and is not expected to alter the growth rate significantly, and because the lethal and nonlethal take adults are a relatively small portion of the population, the proposed level of take is not expected to jeopardize the existence of the ESU.

Take of juvenile Central Valley steelhead will primarily occur at Federal and State facility water pumps in the South Delta. Total lethal take of juveniles is expected to be 17 fish per year (Table 2) representing approximately 0.005 to 0.017 percent of the estimated juvenile population emigrating from freshwater per year (NMFS 2003b). Nonlethal juvenile take is expected to be 634 Central Valley Steelhead per year representing between 0.2 and 0.6 percent of the estimated juvenile population. The removal of juveniles as a result of lethal and nonlethal take will result in a lower juvenile population affecting the cohort replacement rate. Total expected take of adults is estimated at 42 fish, representing approximately 1.17 percent of the estimated adult female spawning population (NMFS 2003b). Approximately 7 percent of the take is expected to be lethal (3 fish) representing 0.08 percent of the adult female spawning population. Assuming an average fecundity of 5,000 eggs per female and a 1 percent egg to smolt survival rate, a loss of 3 adults has the potential to reduce the juvenile population by an average of 75 individuals equaling between 0.025 and 0.075 percent of the following years juvenile population. When adding these estimates to the lethal take of juveniles, the total juvenile take expected to average between 0.22 and 0.67 percent of the juvenile population. Because expected lethal and nonlethal take of juvenile Central Valley steelhead represents a relatively small portion of the juvenile population of the ESU and is not expected to alter the growth rate significantly, and because the lethal and nonlethal take adults are a relatively small portion of the population, the proposed level of take is not expected to jeopardize the existence of the ESU.

Take of Central California Coast steelhead is only expected to occur as a result of project 5, "Estuarine and marine fish abundance and distribution survey." A non lethal take of 2 juvenile California Coast steelhead per year is expected. No juvenile mortality or adult take is expected.

Based on the absence of adult take and low juvenile take relative to the population size, it is not expected to jeopardize the continued existence of the Central California Coast steelhead ESU.

B. Proposed Species

A total of 265 North American green sturgeon are expected to be taken as a result of the proposed research. A total nonlethal take of 254 North American green sturgeon is expected. The effects of nonlethal take range from short-term disruptions of migratory behavior, sheltering, and feeding behaviors, stress resulting in altered metabolic state, to physical injury related to handling as indicated in the *Effects of the Proposed Action* section. Research by Lankford *et al.* (2005) found that exposing North American green sturgeon to physical stressors such as being chased by nets or confinement in holding tanks, resulted in elevated "maintenance" metabolic rates and decreased capability of the fish to deal with additional energy demands such as growth and reproduction; however, in a separate study Lankford found that the stress likely did not affect the overall health of the fish as indicated by growth measurements (Lankford *et al.* 2003). Thus it is assumed the stress related to capture and handling of sturgeon may have short-term impacts to the metabolism of sturgeon, and that there is no evidence for long-term effects to sturgeon health, growth, or reproduction. Approximately 4 percent of the total take is expected to be lethal (*i.e.*, 11 fish are expected to die). Due to the lack of population abundance information regarding the Southern DPS of North American green sturgeon, a variety of estimates must be consulted to estimate the effects of proposed take. Compared to the estimated population size based on CDFG tagging efforts (CDFG 2002), juvenile and sub-adult captures passing Red Bluff Diversion Dam, and past IEP sampling efforts, the lethal take would remove a small portion of the adult and sub-adult North American green sturgeon population. Ratios of tagged white to green sturgeon in San Pablo Bay generated estimates averaging 12,499 sub-adult and adult green sturgeon, and captures of juveniles and sub-adults passing Red Bluff Diversion Dam have exceeded 2,000 in some years. Because of the unknown portion of the Northern DPS population in past San Pablo Bay captures, the estimated take of the Southern DPS likely is lower. In addition, the lethal take of North American green sturgeon is a function of total take and will likely remain at a low of 4 percent as no changes to sampling methods are anticipated. For the overall IEP, more than half the yearly expected nonlethal and slightly less than the yearly expected lethal take is expected to occur as a result of the "Sturgeon tagging program;" however, this effort has an alternating two-year sampling regime avoiding take completely during half of the years. Because expected lethal take of both adult and sub-adult North American green sturgeon appears to represent a relatively small portion of the Southern DPS population and the expected nonlethal take represents a small portion of the population captured (approximately 4 percent when "Sturgeon tagging program" is sampling) the proposed level of take is not expected to jeopardize the existence of the Southern DPS of North American green sturgeon.

VIII. CONCLUSION

A. Listed Species/Designated Critical Habitat

After reviewing the best available scientific and commercial information, the current status of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead and Central California Coast steelhead, the environmental baseline for the action area, the effects of the proposed issuance of Permit 1440, and the cumulative effects, it is NMFS' biological opinion that the issuance of Permit 1440, as proposed, is not likely to jeopardize the continued existence of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and Central California Coast steelhead, or result in the destruction or adverse modification of the designated critical habitat for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and Central California Coast steelhead.

B. Proposed Species

After reviewing the best available scientific and commercial information, the current status of the Southern DPS of North American green sturgeon, the environmental baseline for the action area, the effects of the proposed issuance of Permit 1440, and the cumulative effects, it is NMFS' biological opinion that the issuance of Permit 1440, as proposed, is not likely to jeopardize the continued existence of the Southern DPS of North American green sturgeon.

VIII. INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. Harm is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and 7(o)(2), taking that is incidental to and not intended as part of the proposed action is not considered to be prohibited taking under the Act provided that such taking is in compliance with this incidental take statement.

The issuance of Permit 1440 authorizes intentional take of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, Central California Coast steelhead, and North American green sturgeon associated with the proposed research activities. The action of issuing Permit 1440 does not anticipate incidental take of endangered or threatened species. This opinion does not authorize any taking of a listed species under section 10(a) or immunize any actions from the prohibitions of section 9(a) of the ESA.

IX. REINITIATION OF CONSULTATION

This concludes formal consultation on the issuance of Permit 1440. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded, (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered, (3) the identified action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in this addendum to the Central Valley Research Opinion, or (4) a new species is listed or critical habitat designated that may be affected by the identified action.

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Appendix 1. Latitude and longitude coordinates of sampling stations for the "Estuarine and marine fish abundance survey."

Station	Latitude	Longitude	Description
101	37 32.13	122 10.00	S San Francisco Bay, Chnl 1.4 km E Redwood Cr.
102	37 35.00	122 12.50	S San Francisco Bay, Shl 1.8 km S of Sm-Hayward Br.
103	37 36.20	122 18.17	S San Francisco Bay, Shl 1.9 km near of Coyote Point
104	37 40.78	122 14.20	S San Francisco Bay, Shl NW San Leandro Chnl
105	37 43.17	122 16.25	S San Francisco Bay, Shl SW of Oakland Airport
106	37 42.12	122 22.00	S San Francisco Bay, Shl SE of Candlestick Point
107	37 36.30	122 17.15	S San Francisco Bay, Chnl 3.4 km near Coyote Pt.
108	37 40.55	122 19.78	S San Francisco Bay, Chnl 5 km near Pt San Bruno
109	37 44.35	122 21.20	S San Francisco Bay, Chnl near Hunters Point
110	37 47.32	122 21.55	San Francisco Bay, Chnl 1.5 km S of Yerba Buena Is.
140	37 30.82	122 08.18	S San Francisco Bay, Chnl 0.3 km SE Railroad Br.
142	37 45.71	122 18.32	S San Francisco Bay, Shl 2 km SW Alameda Naval St.
211	37 50.08	122 22.60	San Francisco Bay, Shl 1 km N of Treasure Is.
212	37 51.27	122 21.16	San Francisco Bay, Shl 3.5 km W of Berkeley Hbr
213	37 49.95	122 25.63	San Francisco Bay, Chnl, W of Alcatraz Is.
214	37 51.58	122 24.10	San Francisco Bay, Chnl 1.5 km E of Angel Is.
215	37 53.28	122 25.45	San Francisco Bay, Chnl 1.5 km NE of Angel Is.
216	37 55.25	122 26.18	San Francisco Bay, Chnl SW Red Rock
243	37 53.05	122 24.07	San Francisco Bay, Shl E of Southhampton Shl
244	37 55.42	122 28.08	San Francisco Bay, Shl E Corte Madera Cr. Chnl.
317	37 58.95	122 24.72	San Pablo Bay, Shl 2 km NE of Point San Pablo
318	38 01.28	122 20.70	San Pablo Bay, Shl 2 km NE of Pinole Pt
319	38 02.42	122 17.13	San Pablo Bay, Shl 1.5 km W of Lone Tree Pt
320	38 04.20	122 19.03	San Pablo Bay, Shl N of Pinole Shl across Chnl
321	38 03.97	122 22.05	San Pablo Bay, Shl N of Pinole Shl across Chnl
322	38 03.18	122 24.83	San Pablo Bay, Shl S Petaluma R Chnl Entrance
323	38 01.12	122 25.80	San Pablo Bay, Shl 1 km near Pt San Pedro
325	38 01.80	122 22.30	San Pablo Bay, Chnl 2 km NW of Pinole Pt
345	37 59.85	122 25.45	San Pablo Bay, Chnl N of Pt. San Pablo
346	38 03.33	122 18.00	San Pablo Bay, Chnl Mouth of Carquinez Strait
427	38 02.13	122 09.13	Carquinez Strait, Chnl 0.6 km SW Hwy 680 Br.
428	38 03.72	122 06.32	W Suisun Bay, Chnl near Reserve Fleet Anchorage
429	38 05.15	122 04.61	N Suisun Bay Chnl near Reserve Fleet Anchorage
430	38 06.49	122 03.30	Grizzly Bay Shl NW of Ryer Is. near Suisun Sl. Chnl
431	38 06.31	122 01.68	Grizzly Bay Shl N of Ryer Is. E of Simmons Is.
432	38 02.55	122 06.48	Suisun Bay, Sacramento R. Chnl E of Hwy 680 Br.
433	38 03.59	121 15.70	Sacramento River, Chnl near Port Chicago
447	38 03.05	122 10.33	Carquinez Strait, Shl S of Benicia Boat Ramp
534	38 04.18	121 56.73	Honker Bay, Shl (Center)
535	38 02.73	121 53.80	Sacramento R., Channel S of Chipps Is
736	38 03.90	121 48.48	Sacramento R., Chnl N of Sherman Lake
750	38 04.66	121 45.23	Sacramento River, Chnl 1 km SW Decker Is
751	38 06.33	121 43.02	Sacramento R., Chnl N end of Decker Is
752	38 06.68	121 42.72	Sacramento R., Shl N end of Decker Is
760	38 09.57	121 40.72	Sacramento R., Shl Downstream Rio Vista Bridge
761	38 10.50	121 40.24	Sacramento R., Chnl at confluence of Steamboat
762	38 10.65	121 39.71	Sacramento R., Shl at confluence with Steamboat

837	38 01.47	121 45.60	San Joaquin R., Shl between W Is. and Antioch Br.
853	38 01.71	121 44.22	San Joaquin R., Chnl E of Antioch Br.
863	38 05.36	121 38.86	San Joaquin R., Santa Clara Shl
864	38 06.07	121 35.88	San Joaquin R., Channel next to San Andreas Shl.
865	38 04.59	121 34.36	San Joaquin R., Shoal at Old River Flats

Appendix 2. Latitude and longitude coordinates of sampling stations for the "Delta smelt 20-mm survey."

Station	Longitude	Latitude
323	38°02'53.9"N	122°16'58.1"W
340	38°05'57.4"N	122°15'48.4"W
342	38°08'45.1"N	122°17'06.3"W
343	38°11'08.9"N	122°18'39.5"W
344	38°12'44.9"N	122°18'25.8"W
345	38°13'54.4"N	122°17'33.9"W
346	38°14'27.3"N	122°17'07.3"W
347	38°15'17.7"N	122°17'00.3"W
348	38°16'23.1"N	122°17'04.7"W
349	38°17'10.1"N	122°17'00.2"W
405	38°02'22.9"N	122°09'01.8"W
411	38°03'04.7"N	122°04'59.9"W
418	38°03'53.3"N	122°05'52.1"W
501	38°05'17.6"N	122°00'12.9"W
504	38°03'39.8"N	122°00'49.4"W
508	38°02'43.8"N	121°55'07.7"W
513	38°03'29.9"N	121°52'04.8"W
519	38°04'20.3"N	121°57'34.9"W
520	38°01'58.1"N	121°52'09.5"W
602	38°06'50.4"N	122°02'46.3"W
606	38°10'10.1"N	122°01'32.4"W
609	38°10'01.9"N	121°56'16.8"W
610	38°07'07.7"N	121°53'21.1"W
703	38°02'31.9"N	121°47'42.8"W
704	38°04'09.0"N	121°46'31.0"W
705	38°05'13.6"N	121°42'33.0"W
706	38° 05'06.7"N	121 45'02.5"W
707	38°06'48.6"N	121°42'27.0"W
711	38°10'43.7"N	121°39'55.1"W
716	38°15'29.8"N	121°41'29.9"W
801	38°02'37.3"N	121°50'38.4"W
804	38°01'05.5"N	121°47'49.2"W
809	38°03'90.0"N	121°41'21.1"W
812	38°05'25.1"N	121°38'25.8"W
815	38°04'48.0"N	121°34'11.3"W
901	38°02'53.8"N	121°35'42.9"W
902	38°01'09.1"N	121°34'55.9"W
906	38°03'06.1"N	121°30'32.4"W
910	38°00'06.5"N	121°26'55.3"W

Appendix 3. Latitude and longitude coordinates of sampling stations for the "Spring Kodiak trawl survey."

Station	Latitude	Longitude	Description	Depth
Day 1:				
809	38°03'09"N	121°41'21.1"W	N. Channel opposite Jersey Pt.	42'
902	38°01'09.1"N	121°34'55.9"W	Holland Tract Levee, Old River	26'
915	37°56'33"N	121°33'48.6"W	Old River W of railroad	30'
914	37°58'17.4"N	121°31'12"W	Middle River at Empire Cut	31'
910	38°0'06.5"N	121°26'55.3"W	San Joaquin, between Hog Sl. & Turner Cut	38'
906	38°03-06.1"N	121°30'32.4"W	San Joaquin at Medford Island	38'
919	38°06'17.3"N	121°29'31.2"W	Little Potato Sl. near Terminous	
920	38°8'30.4"N	121°30'10.8"W	S. Fork Mokelumne R. at Sycamore Sl	
921	38°9'50.2"N	121°29'31.8"W	S. Mokelumne R. at mouth of Hog Sl	
922	38°11'39.8"N	121°28'40.8"W	S Mokelumne R. at mouth of Beaver Sl.	
923	38°8'17.0"N	121°33'22.6"W	Mokelumne R. in bend above S. Mokelumne R.	
815	38°04'48"N	121°34'11.3"W	San Joaquin, mouth of Potato Sl	17'
812	38°05'25.1"N	121°38'25.8"W	San Joaquin, W of Oulton Pt.	20'
Day 2				
340	38°05'51"N	122°15'43.9"W	Napa R., along Vallejo Seawall and Park	10'
405	38°02'22.9"N	122°09'01.8"W	Carquinez St. W of Benicia Army Dock	10'
418	38°03'53.3"N	122°05'52.1"W	Suisun Bay, Mothball Fleet	35'
411	38°03'04.7"N	122°04'59.9"W	Suisun Bay, W of Pt Edith 10'	
501	38°04'21"N	122°01'30.7"W	Suisun Bay, between Roe and Ryer Is.	22'
602	38°06'50.4"N	122°02'46.3"W	Grizzly Bay near Suisun Sl. at Dolphin	4'
606	38°10'10.1"N	122°01'32.4"W	Montezuma Sl. off Joice Is.	25'
609	38°10'01.9"N	121°56'16.8"W	Montezuma Sl. at Nurse Sl.	33'
610	38°07'07.7"N	121°53'21.1"W	Montezuma Sl. near Bird's Landing	13'
706	38°05'06.7"N	121°45'02.5"W	Sac. R., below S Tip of Decker Is	22'
707	38°06'48.6"N	121°42'27"W	Sac. R., at 3 Mile Sl.	24'
Day 3				
716	38°14'28.8"N	121°41'8.4"W	Cache Sl N of Cable Ferry 1&51	30'
715	38°13'19.9"N	121°40'19.2"W	Cache Sl N of Light 47	
713	38°12'20.2"N	121°39'28.8"W	Cache Sl N of Light 43	
711	38°10'43.7"N	121°39'55.1"W	Sac. R. at tip of Grand Is.	13'
712	38°11'36.5"N	121°37'21.4"W	Steamboat Sl N of Windmills	
725	38°14'23.7"N	121°30'58.8"W	Sac. R.at Georgiana Sl.	
704	38°04'09"N	121°46'31"W	Sac. R. near Sherman Lake	26'
513	38°03'29.9"N	121°52'04.8"W	Sac. R. between Van Sickle & Winter Is.	30'
508	38°02'43.8"N	121°55'07.7"W	Suisun Bay off Chipps Is.	55'
519	38°04'20.3"N	121°57'34.9"W	Honker Bay W end at Dolphin	9'
504	38°03'16.2"N	121°59'°22.2"W	Suisun Bay E. of Middle Pt.	22'
520	38°01'58.1"N	121°52'09.5"W	New York Sl. W end of Pittsburg Docks	38'
801	38°02'37.3"N	121°50'38.4"W	Middle of Broad Slough, W end	22'
804	38°01'05.5"N	121°47'49.2"W	San Joaquin, 1 km upstream of mouth	30'

Appendix 4. Latitude and longitude coordinates of sampling stations for the "UC Davis Suisun Marsh fish monitoring."

Current sampling sites (1994-present)

Site	Latitude	Longitude	Slough
SU1	38°13'2.0"N	122°01'43.1"W	Suisun
SU2	38°12'8.2"N	122°02'22.7"W	Suisun
SU3	38°08'22.0"N	122°04'22.7"W	Suisun
SU4	38°07'36.0"N	122°04'51.4W	Suisun
PT1	38°13'38.1"N	122°03'4.5"W	Peytonia
PT2	38°13'18.0"N	122°02'34.5"W	Peytonia
BY1	38°12'40.0"N	122°03'12.5"W	Boynton
BY3	38°12'41.3"N	122°02'38.3"W	Boynton
CO1	38°11'33.6"N	122°01'35.5"W	Cutoff
CO2	38°11'21.7"N	122°01'13.1"W	Cutoff
SB1	38°12'2.8"N	122°01'48.5"W	Spring Branch
SB2	38°11'57.1"N	122°01'53.5"W	Spring Branch
GY1	38°06'8.3"N	122°05'36.2"W	Goodyear
GY2	38°06'27.5"N	122°05'52.1"W	Goodyear
GY3	38°07'55.8"N	122°05'10.4"W	Goodyear
MZ1	38°05'36.6"N	122°53'9.5"W	Montezuma
MZ2	38°07'5.2"N	122°53'18.5"W	Montezuma
NS2	38°11'0.3"N	122°55'32.6"W	Nurse
NS3	38°10'19.6"N	122°55'41.8"W	Nurse
DV2	38°12'10.6"N	122°54'23.2"W	Denverton
DV3	38°11'55.0"N	121°54'3.9"W	Denverton

Table 1. Description of long-term and short-term IEP projects.

Number	Project	Description	Sampling Site	Gear	Frequency	Collected Data
	Long-term Studies					
1	Adult Striped Bass Population Parameters	Evaluate population dynamics of striped bass in the estuary.	Lower Sacramento and San Joaquin Rivers, Sacramento River at Knights Landing, and Clifton Court Forebay	Gill-nets: variable-mesh, 200 fathoms long, 21 feet deep, and mesh of 4, 4.5 and 5.5 inches; Anchored gill nets: 4 m by 61 m monofilament nets with 6-10 cm stretched mesh; Hook-and-line: 360 angler hours; Fyke nets: 20 ft by 10 ft cylinders constructed of chain link material.	up to 7 d/wk Feb-Nov	1969-present
2	Fall Mid-water Trawl	Abundance and distribution of striped bass and other delta dependant species.	South of Dumbarton Bridge in San Francisco Bay to Rio Vista in the Sacramento and False River on the San Joaquin River in the western Delta	Midwater trawl: 12 ft x 12 ft mouth, 58 ft long, 1/2 inch mesh	7-8 d/mo, Sep-Dec	1967-present (except 1974 and 1979)
3	Adult Sturgeon Tagging	Measurement of sturgeon population parameters such as survival rates, abundance, and growth rates.	San Pablo Bay	Trammel net: 200 fathoms long and 21 ft deep with variable-meshes at 6, 7, and 8 inches.	5 d/wk, Aug-Oct	1954-present (intermittently)
4	Delta Resident Shoreline Fish Monitoring	Identify long-term trends in abundance, species interactions, and size distribution of resident fishes.	Various sites throughout the Delta	Boat Electrofishing (6 amps electrical current with 5 ft radius)	monthly	1978-1985, 1995-present
5	Estuarine and Marine Fish Abundance and Distribution Survey	Study effects of freshwater outflow on abundance and distribution of estuarine and marine fishes, brachyuran crabs, and caridean shrimp.	South of Dumbarton Bridge in San Francisco Bay to Rio Vista in the Sacramento and False River on the San Joaquin River in the western Delta	Midwater trawl: 12 ft x 12 ft mouth, 58 ft long, 1/2 inch mesh; Otter trawl: 16 ft mouth, 35 ft long; 1 inch mesh body; 1/2 mesh cod end	monthly	1979-present
6	Delta Smelt 20-mm Survey	Survey distribution juvenile delta smelt throughout historic range.	San Pablo Bay to Eastern Delta	Plankton net: 5.1 m long, 1600 micron mesh	every 14 d, Mar-Aug	1995-present
7	Real-time Monitoring	Provide information on salvage counts and operations within 48 h to minimize water project impacts on fisheries (Chinook salmon, delta smelt, splittail).	Mossdale in San Joaquin River	Kodiak trawl: 7.9 m x 1.8 m mouth, 19.3 m long, 38.1 mm mesh body, 6.4 mm mesh at cod end	5 d/wk in Apr-Jun	1995-present
8	Spring Kodiak Trawl Survey	Survey distribution of pre-spawning delta smelt.	Napa River to Walnut Grove on the Sacramento River and to Stockton on the San Joaquin River	Kodiak trawl: 25 ft x 6 ft, 65 ft long, 2 in mesh body to 1/4 inch mesh at cod end	6 d in Feb-Mar	1991-present
9	UC Davis Suisun Marsh Fish Monitoring	Monitor fish populations and habitat use in Suisun Marsh.	Small sloughs: Spring Branch, Cutoff, Peytonia, Boynton, Denverton, Nurse, Goodyear; Large sloughs: Montezuma and Suisun	Otter trawl: 1 m x 2 m mouth, 5.3 m long, 35 mm body mesh, 6 mm mesh at cod end; Beach seine: 10 m, 6 mm mesh, 0.5 to 1.5 m depths;	monthly	1979-present
10	South Delta Temporary Barriers Fish Monitoring	Monitor effects of barrier design on fish species in San Joaquin River	Head of Old River on San Joaquin River	Fyke net: 48 inch diameter mouth, 60 ft long, 1/4 inch mesh with live box;	24 h/day in Apr-May	1997-present

Table 1. Description of long-term and short-term IEP projects.

Number	Project	Description	Sampling Site	Gear	Frequency	Collected Data
	Short-term Studies (2004-2006)					
11	Yolo Bypass fish monitoring	Collect baseline biological and physical data (juvenile and adult fish), and study effects of pesticides on fauna, and effects of managed seasonal flooding on food webs.	Yolo Bypass	Drift net: 0.46 m x 0.3 m mouth, 0.91 m long, 500 micron mesh; Rotary screw trap: 8 ft; Fyke trap: 10 ft diameter; Larval fish net: 2 ft diameter, 8 ft length, 500 micron mesh.	year-round	1998-2005
12	Development of diagnosis indicators to predict acute or chronic adverse effects to salvaged delta smelt	Develop diagnostic tools to assess sublethal effects of CHTR-related stresses on delta smelt to determine stress level on salvaged smelt process and measure CHTR impacts on swimming performance and reproductive success.	Montezuma Slough to Horseshoe Bend	Purse seine: 125 ft x 20 ft, 1/16 inch mesh	Oct-Dec	2004-2006
13	Assessment of fish predation occurring in the collection, handling, transport, and release phase of the State Water Project's John E. Skinner Delta Fish Protective Facility salvage operation	Determine occurrence and magnitude fish predation in the CHTR process.	Use fish salvaged at Tracy Fish Collection Facility	No field sampling	Dec-May	2003-2006
14	Acute mortality and injury of delta smelt associated with collection, handling, transport, and release at State Water Project and Central Valley Project Fish Salvage Facilities	Measure acute mortality and injury rates of delta smelt during high entrainment periods.	Montezuma Slough to Horseshoe Bend	Purse seine: 125 ft x 20 ft; 1/16 inch mesh	May-Jul, Dec-Mar	2004-2006
15	Morrow Island Distribution System Diversion Evaluation	Compare entrainment losses of fish under different operational configurations.	Goodyear Slough, MIDS diversion intake culverts	Purse seine: 30 m x 3 m; 3.2 mm mesh; Fyke net: 5 m x 1.6 mm mesg	1d/wk Sept-May	2004-2006

Table 2. Estimated annual take of ESA-listed salmonids resulting from all 12 IEP projects.

			Winter-run Chinook Salmon				*Spring-run Chinook Salmon*				*Central Valley steelhead*				*Central California Coast steelhead*			
			Adult		Juvenile		Adult		Juvenile		Adult		Juvenile		Adult		Juvenile	
Number	Project	Take Activity	Non-lethal	Lethal	Non-lethal	Lethal	Non-lethal	Lethal	Non-lethal	Lethal	Non-lethal	Lethal	Non-lethal	Lethal	Non-lethal	Lethal	Non-lethal	Lethal
	Long-term Studies																	
1	Adult Striped Bass Population Parameters	handle	18	2	0	0	79	9	0	0	10	2	0	0	0	0	0	0
2	Fall Mid-water Trawl	handle, retain CWT salmonids	2	0	10	2	1	0	10	2	2	0	2	0	0	0	0	0
3	Adult Sturgeon Tagging	handle	2	0	0	0	2	0	0	0	5	0	0	0	0	0	0	0
4	Delta Resident Shoreline Fish Monitoring	handle	1	0	18	2	1	0	18	2	2	0	34	4	0	0	0	0
5	Estuarine and Marine Fish Abundance and Distribution Survey	measure	0	0	6	2	0	0	98	2	1	0	3	2	0	0	2	0
6	Delta Smelt 20-mm Survey	handle	0	0	5	0	0	0	4	1	1	0	3	0	0	0	0	0
7	Real-time Monitoring	handle, retain CWT salmonids	0	0	8	2	0	0	3	2	1	0	13	2	0	0	0	0
8	Spring Kodiak Trawl Survey	handle, retain CWT salmonids	3	0	20	2	3	0	290	10	3	0	18	2	0	0	0	0
9	UC Davis Suisun Marsh Fish Monitoring	handle	1	0	3	2	1	0	3	2	1	0	3	2	0	0	0	0
10	South Delta Temporary Barriers Fish Monitoring	measure, process CWT	0	0	19	1	0	0	4	1	0	0	2	0	0	0	0	0
		Take from long-term projects	**27**	**2**	**89**	**13**	**87**	**9**	**430**	**22**	**26**	**2**	**78**	**12**	**0**	**0**	**2**	**0**
	Short-term Studies (2004-2006)																	
11	Yolo Bypass fish monitoring	measure, retain fin-clipped salmon	9	1	45	5	10	1	450	50	9	1	45	5	0	0	0	0
12	Development of diagnosis indicators to predict acute or chronic adverse effects to salvaged delta smelt	handle	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
13	Assessment of fish predation occurring in the collection, handling, transport, and release phase of the State Water Project's John E. Skinner Delta Fish Protective Facility salvage operation	handle	0	0	15	0	0	0	20	0	0	0	10	0	0	0	0	0
14	Acute mortality and injury of delta smelt associated with collection, handling, transport, and release at State Water Project and Central Valley Project Fish Salvage Facilities	handle	0	0	15	0	2	0	45	0	3	0	500	0	0	0	0	0
15	Morrow Island Distribution System Diversion Evaluation	handle	0	0	1	0	0	0	5	0	1	0	1	0	0	0	0	0
		Take from short-term projects	**9**	**1**	**76**	**5**	**13**	**1**	**520**	**50**	**13**	**1**	**556**	**5**	**0**	**0**	**0**	**0**
		Total take	**36**	**3**	**165**	**18**	**100**	**10**	**950**	**72**	**39**	**3**	**634**	**17**	**0**	**0**	**2**	**0**

Table 3. Requested annual take of North American green sturgeon resulting from all 15 IEP projects.

Number	Project	Take Activity	Non-lethal	Lethal
	Long-term Studies			
1	Adult Striped Bass Population Parameters	handle	15	3
2	Fall Mid-water Trawl	handle, retain CWT salmonids	0	0
3	Adult Sturgeon Tagging	handle	210	5
4	Delta Resident Shoreline Fish Monitoring	handle	0	0
5	Estuarine and Marine Fish Abundance and Distribution Survey	measure	10	3
6	Delta Smelt 20-mm Survey	handle	0	0
7	Real-time Monitoring	handle, retain CWT salmonids	0	0
8	Spring Kodiak Trawl Survey	handle, retain CWT salmonids	0	0
9	UC Davis Suisun Marsh Fish Monitoring	handle	10	0
10	South Delta Temporary Barriers Fish Monitoring	measure, process CWT	0	0
		Take from long-term projects	**245**	**11**
	Short-term Studies (2004-2006)			
11	Yolo Bypass fish monitoring	measure, retain fin-clipped salmon	3	0
12	Development of diagnosis indicators to predict acute or chronic adverse effects to salvaged delta smelt	handle	0	0
13	Assessment of fish predation occurring in the collection, handling, transport, and release phase of the State Water Project's John E. Skinner Delta Fish Protective Facility salvage operation	handle	3	0
14	Acute mortality and injury of delta smelt associated with collection, handling, transport, and release at State Water Project and Central Valley Project Fish Salvage Facilities	handle	3	0
15	Morrow Island Distribution System Diversion Evaluation	handle	0	0
		Take from short-term projects	**9**	**0**
		Total take	**254**	**11**

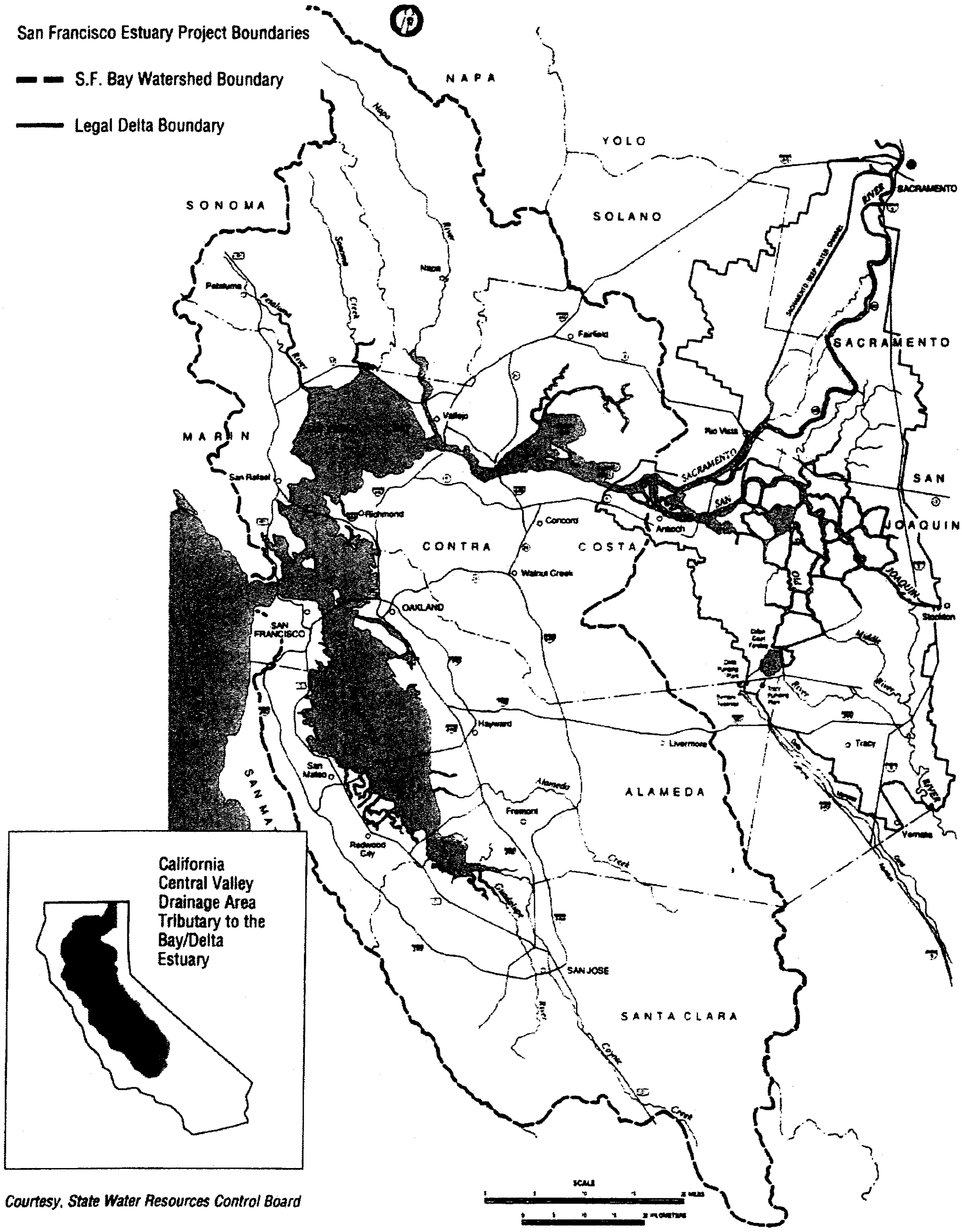


Figure 1. Map of the San Francisco Estuary, which includes the Sacramento-San Joaquin Delta (Figure from the San Francisco Estuary Project 1992).

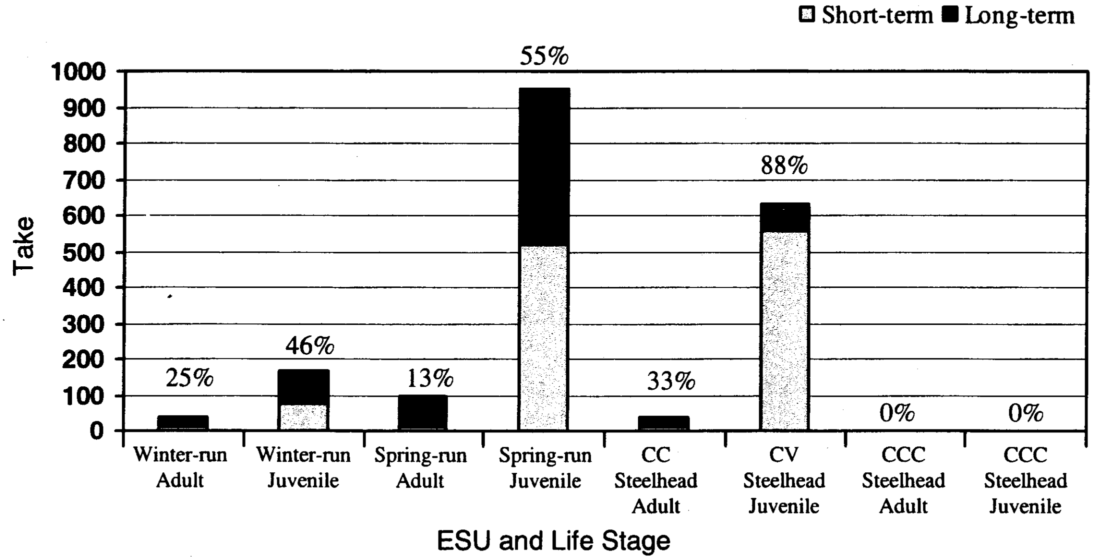


Figure 2. Total nonlethal take of juvenile and adult Sacramento River winter-run and Central Valley spring-run Chinook salmon, Central Valley steelhead, and California Coastal Steelhead from all IEP projects, separating take from long-term (n=10) and short-term projects (n=5). Numbers indicate percentage of nonlethal take expected from short-term projects.

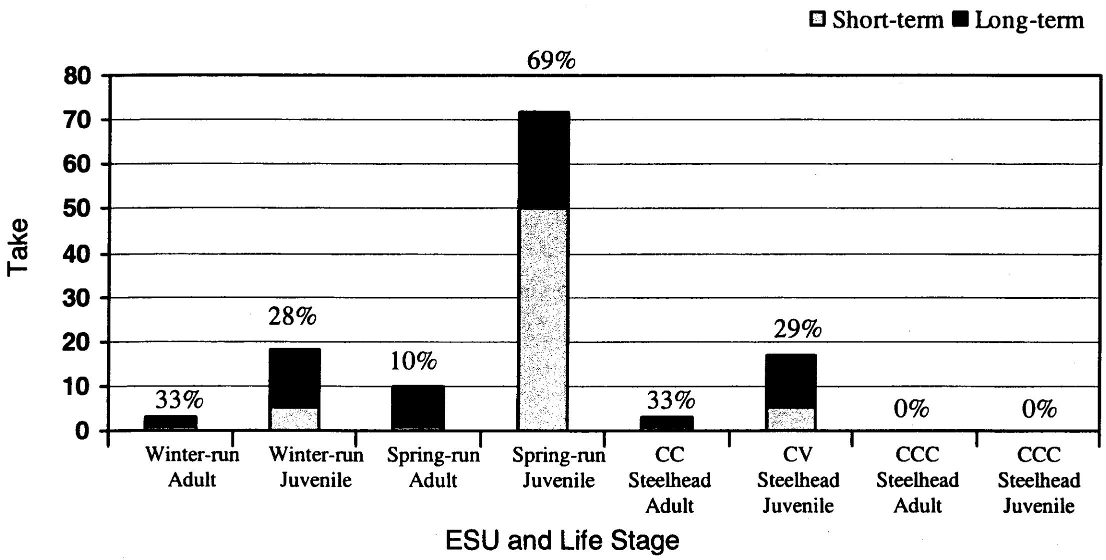


Figure 3. Total lethal take of juvenile and adult Sacramento River winter-run and Central Valley spring-run Chinook salmon, Central Valley steelhead, and California Coastal Steelhead resulting from unintentional fish mortalities from all IEP projects showing proportion of lethal take from long (n=10) and short-term projects (n=5). Numbers indicate percentage of lethal take expected from short-term projects.

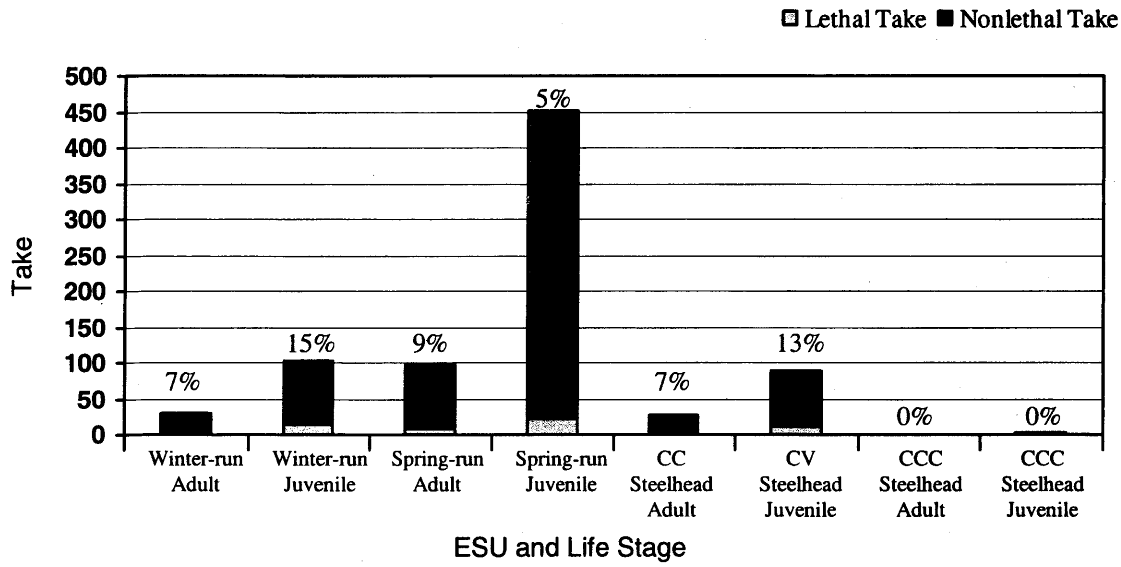


Figure 4. Proportion of nonlethal vs. lethal of juvenile and adult Sacramento River winter-run and Central Valley spring-run Chinook salmon, Central Valley steelhead, and California Coastal Steelhead take resulting from all IEP's long-term projects. Numbers indicate percentage of lethal take expected from long-term projects.

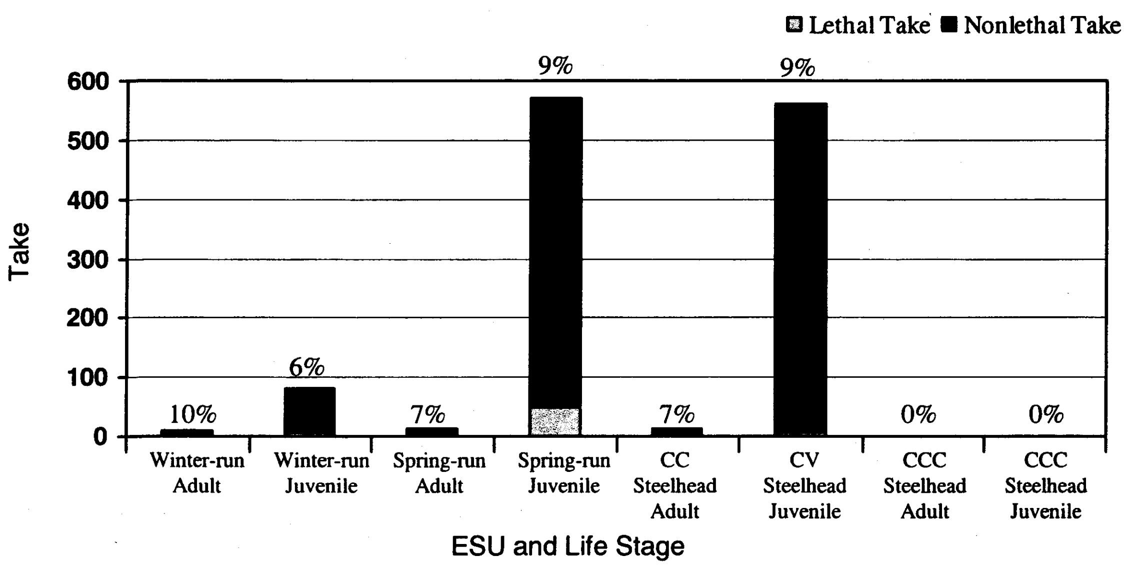


Figure 5. Proportion of nonlethal take vs. lethal take of juvenile and adult Sacramento River winter-run and Central Valley spring-run Chinook salmon, Central Valley steelhead, and California Coastal Steelhead resulting from IEP's short-term projects. Numbers indicate percentage of lethal take expected.

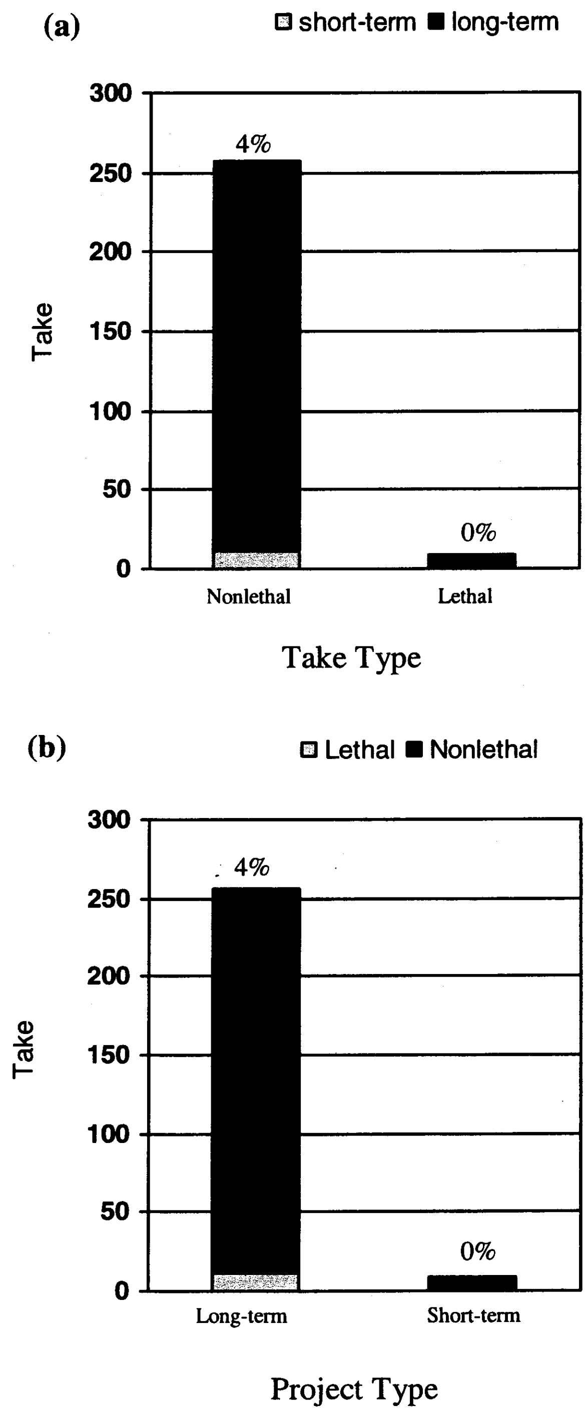
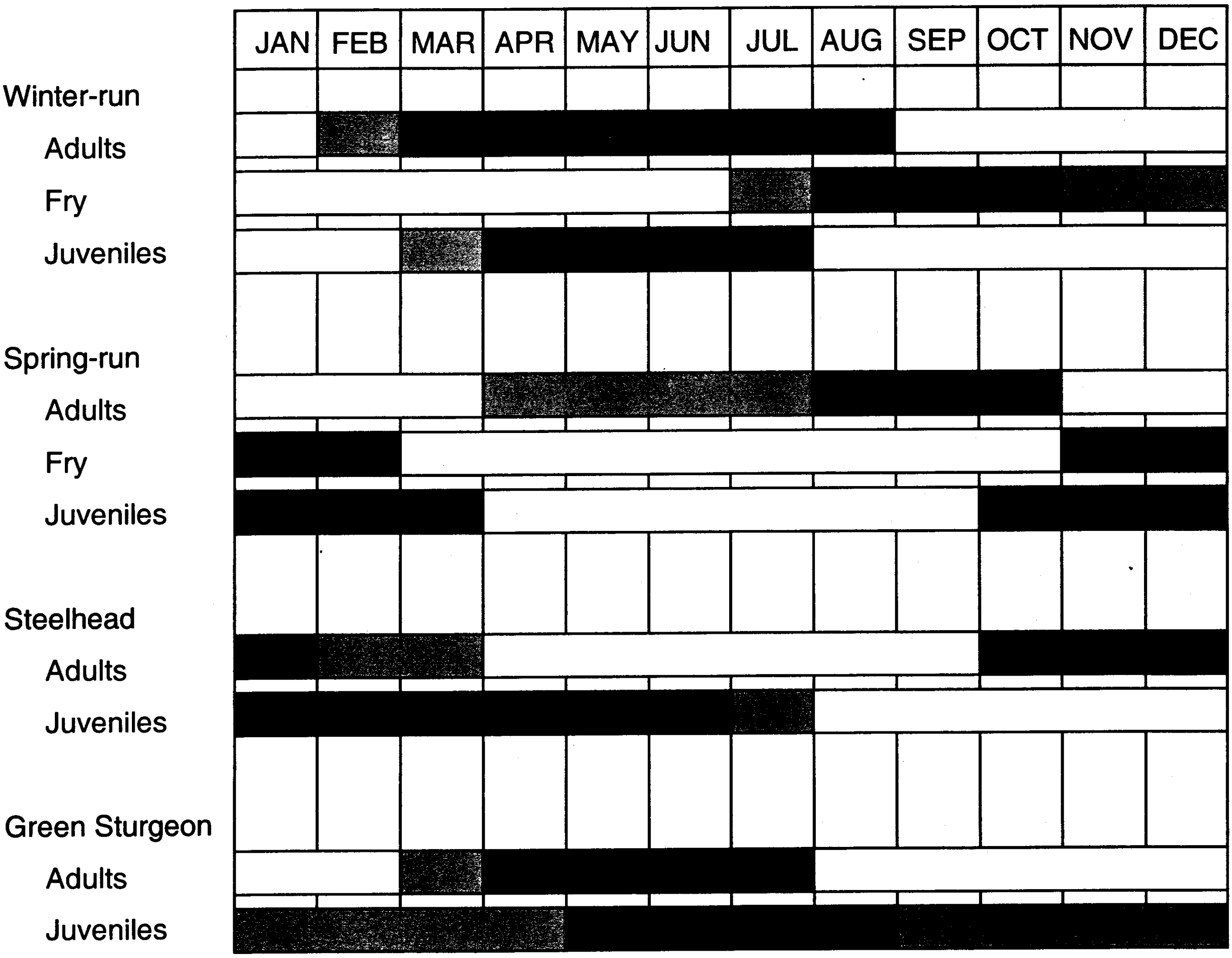


Figure 6. Total nonlethal take for short and long-term projects (a), and proportion of nonlethal vs. lethal take of long-term projects and proportion of nonlethal take vs. lethal take of short-term projects requested for North American green sturgeon (b).



LEGEND:

0%

1-25%

26-50%

> 50%

NOTES: Salmon adults are in cumulative percent. Other life stages are the percent of year's brood. Salmon occurrence adopted from USFWS 1995. Central Valley steelhead occurrence based on temporal distribution as described by IEP 1998. Green sturgeon occurrence follows CDFG 2002 and NMFS 2002.

Figure 7. Occurrence of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and North American green sturgeon in the Sacramento River Basin.

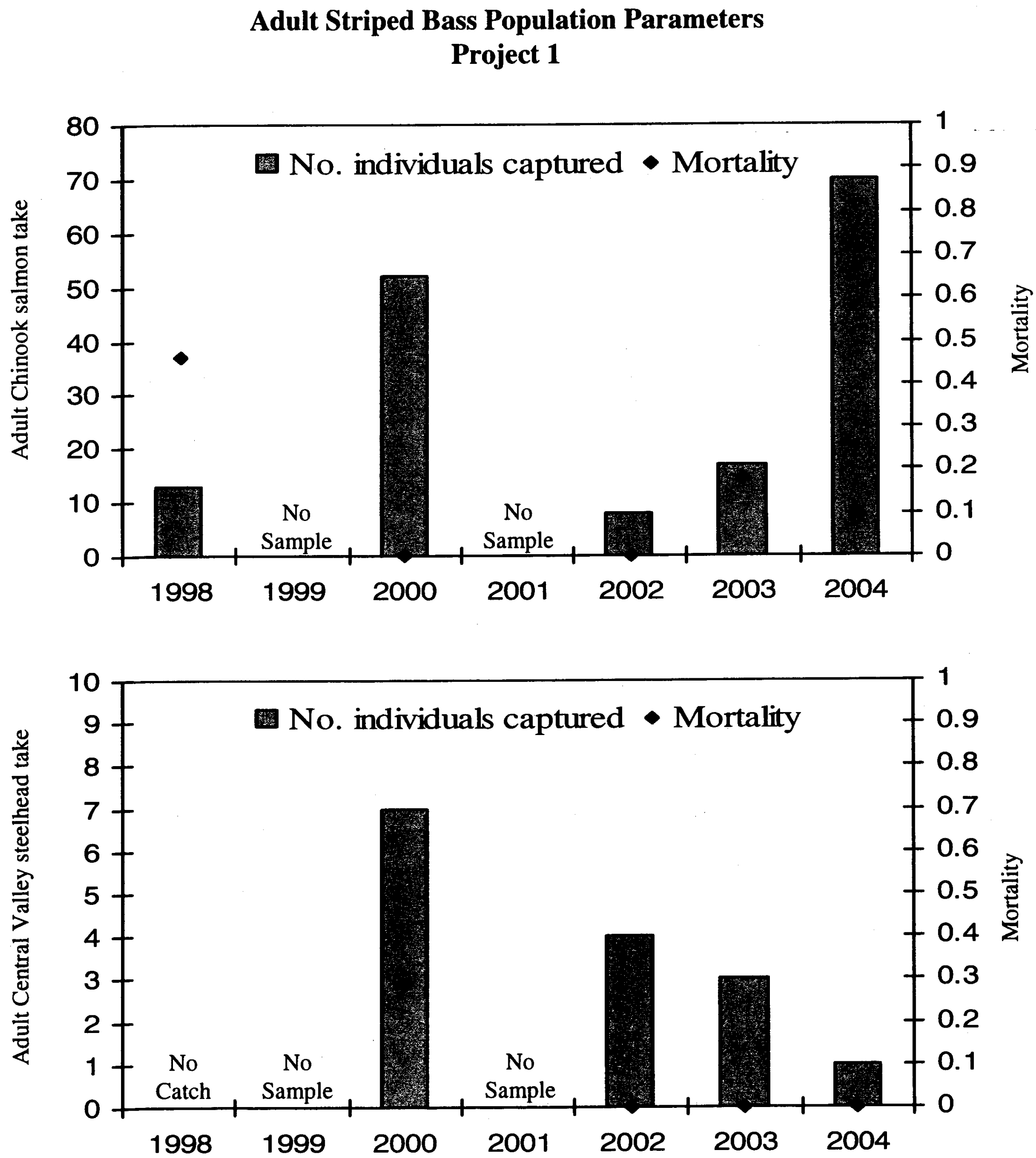
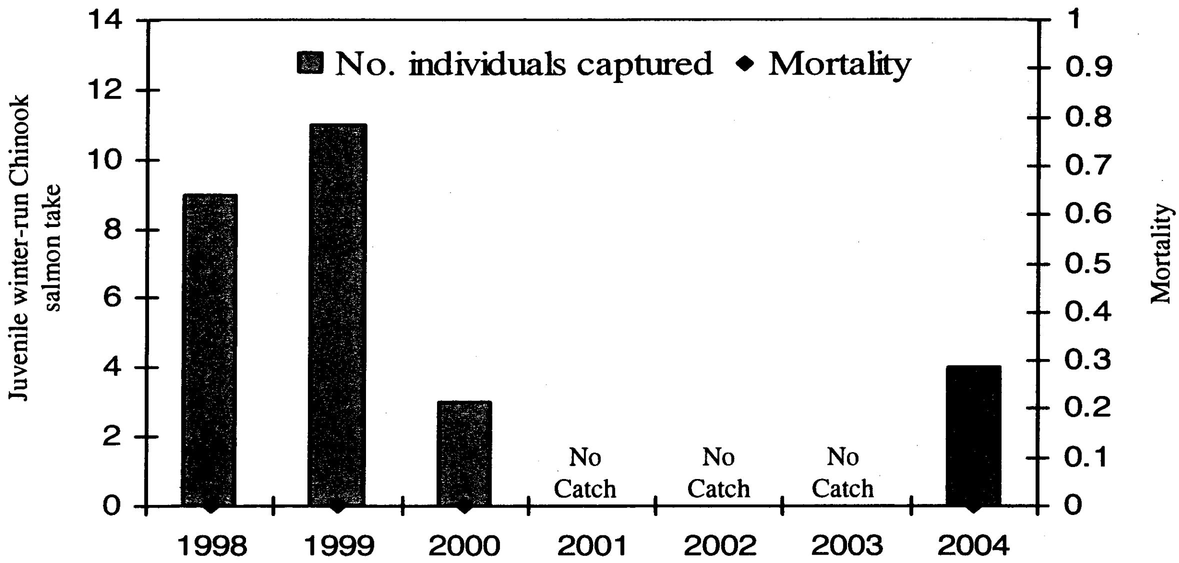


Figure 8a. Number of individual fish captured and corresponding mortality for each long-term project between 1998 and 2004.

Fall Mid-water Trawl
Project 2



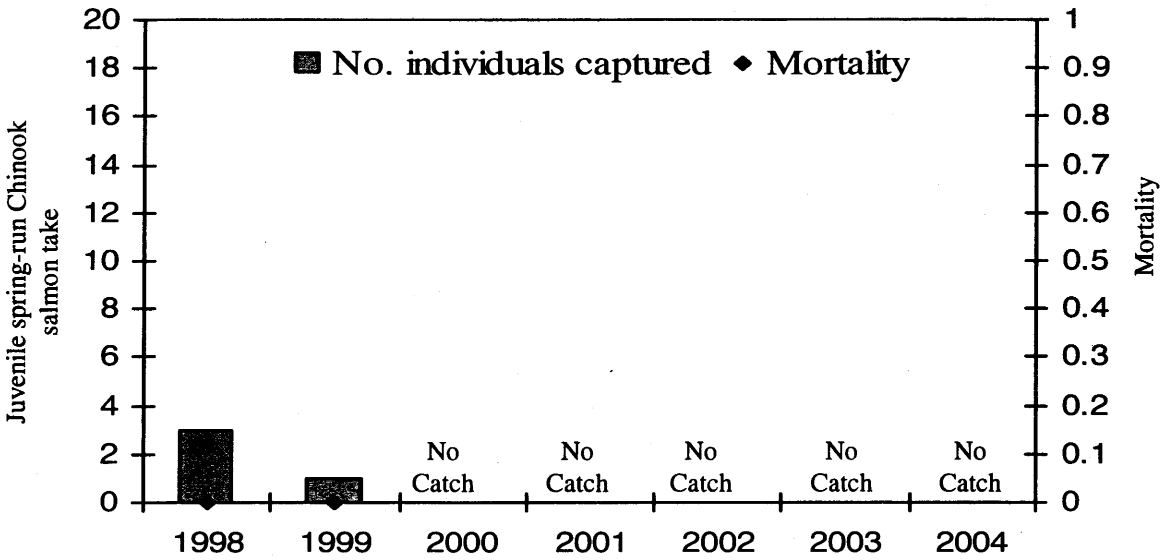
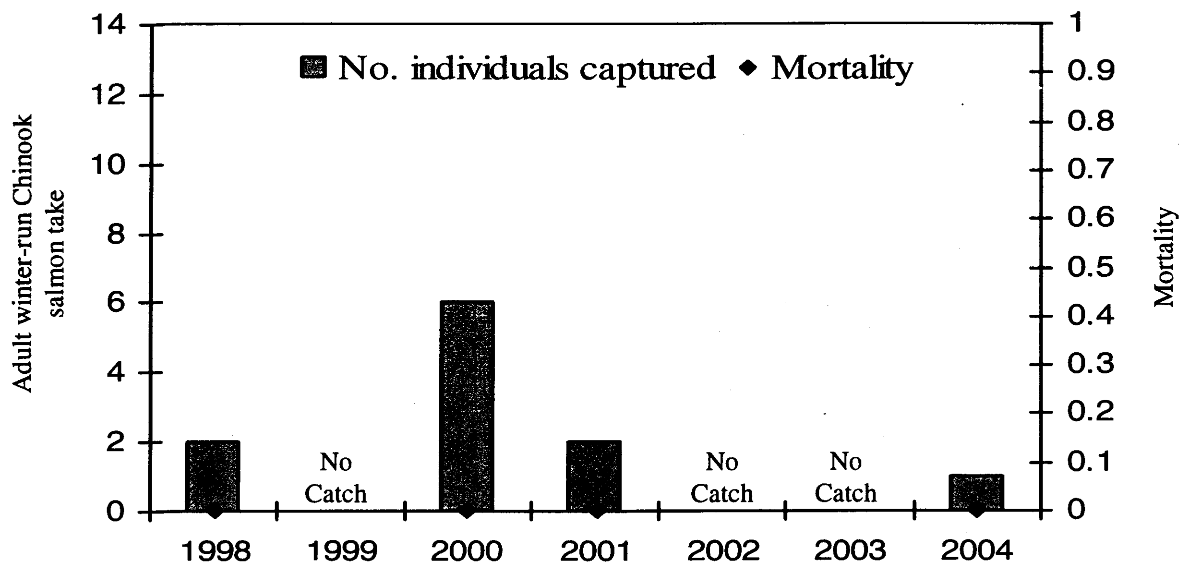


Figure 8b. Number of individual fish captured and corresponding mortality for each long-term project between 1998 and 2004.

Fall Mid-water Trawl
Project 2



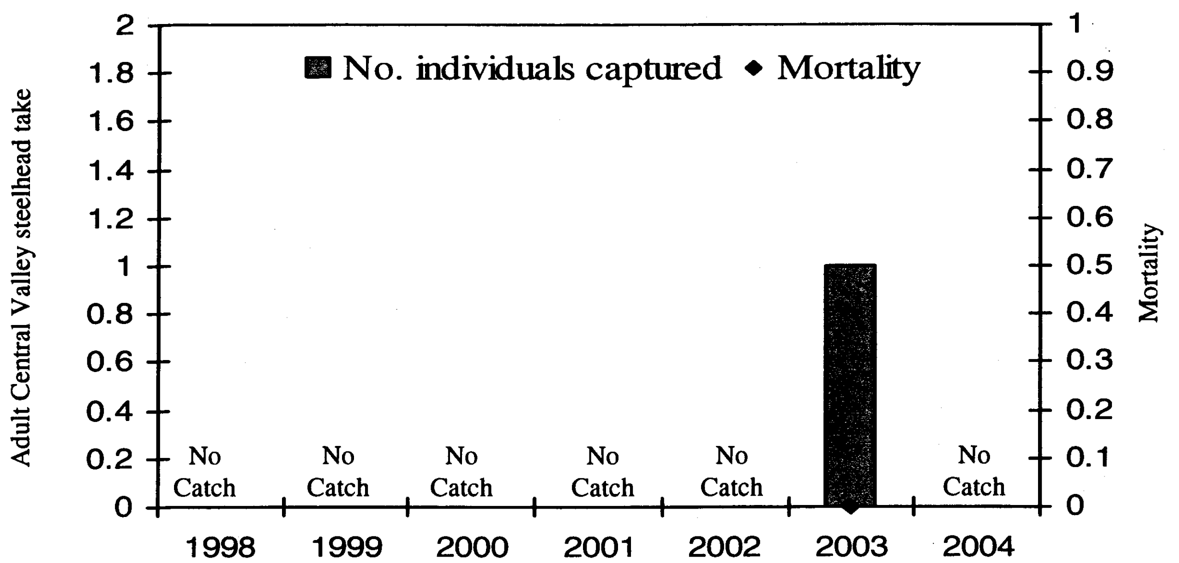


Figure 8b. Number of individual fish captured and corresponding mortality for each long-term project between 1998 and 2004.

Adult Sturgeon Tagging
Project 3

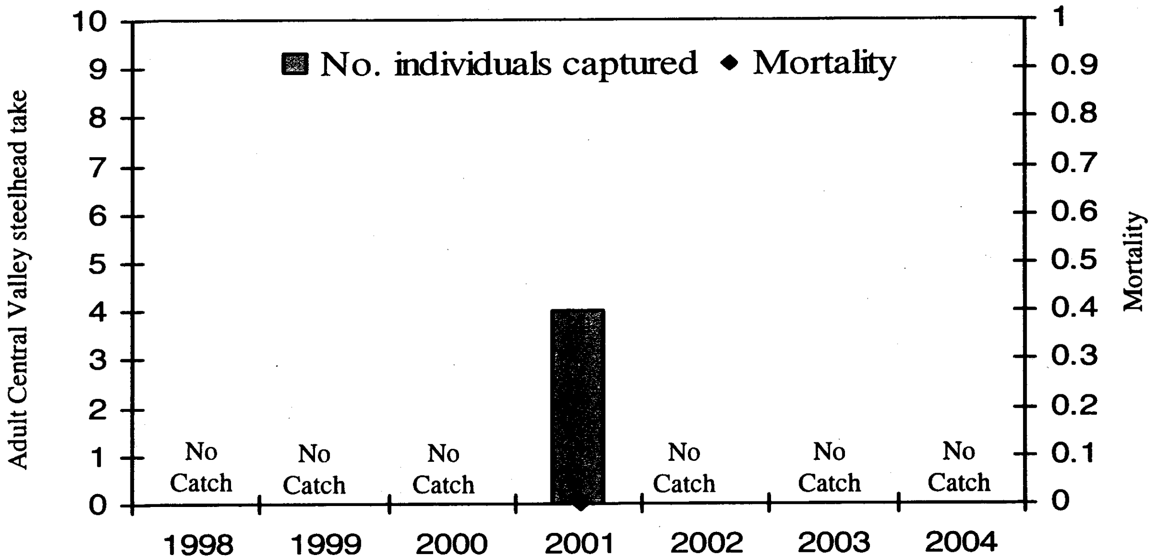


Figure 8c. Number of individual fish captured and corresponding mortality for each long-term project between 1998 and 2004.

Delta Resident Shoreline Fish Monitoring
Project 4

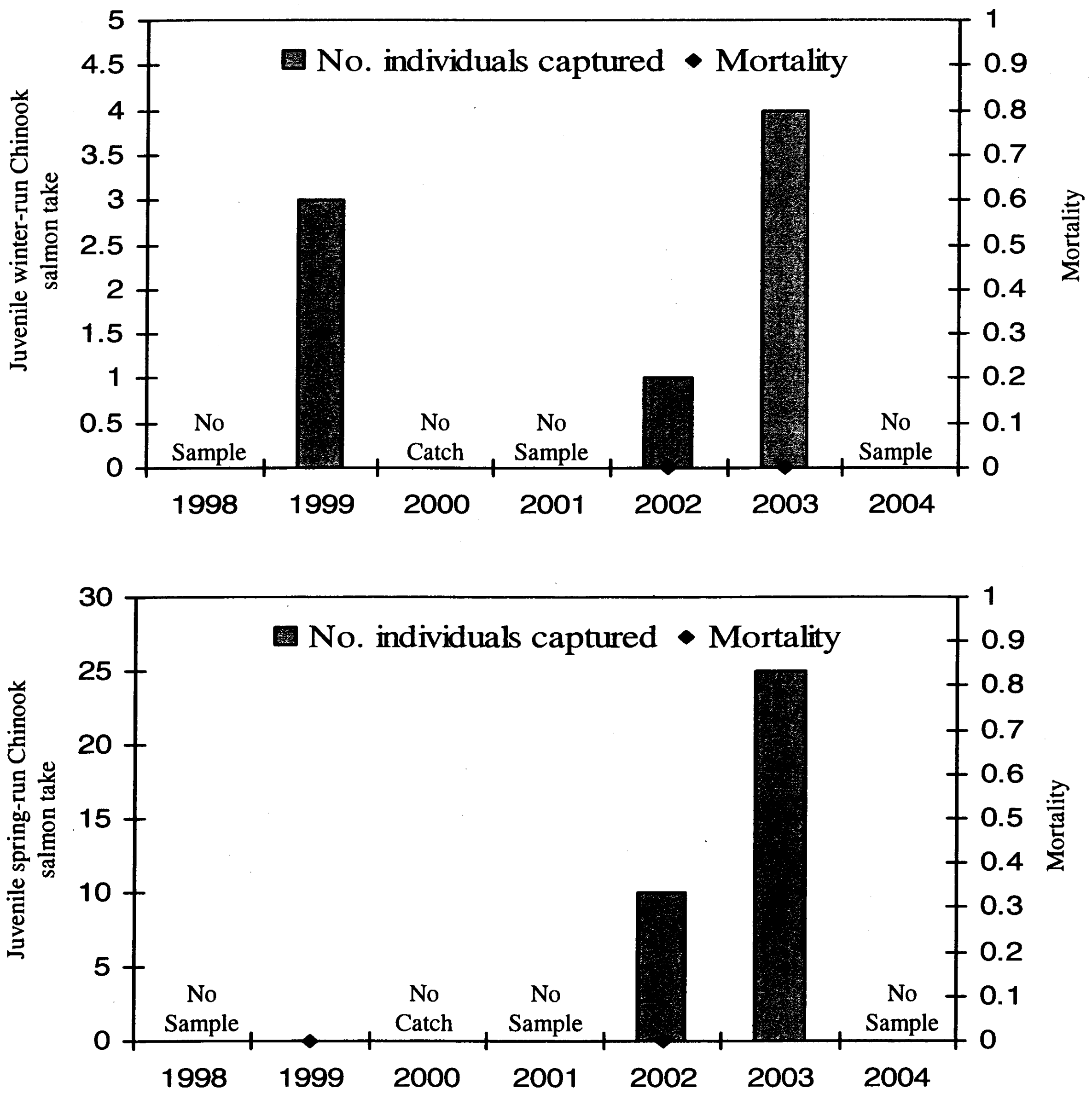
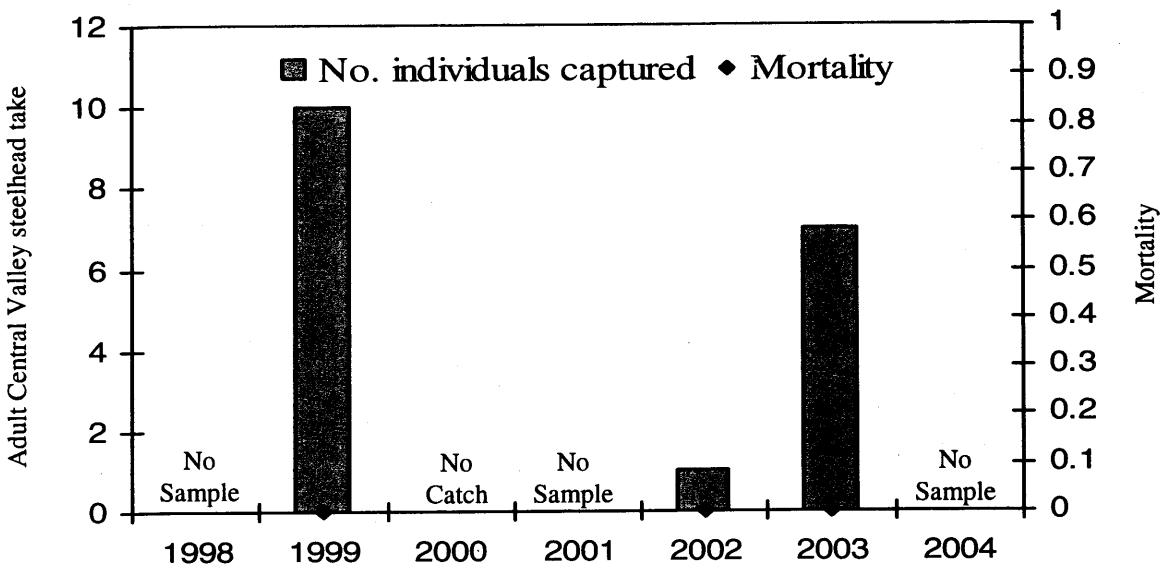


Figure 8d. Number of individual fish captured and corresponding mortality for each long-term project between 1998 and 2004.

Delta Resident Shoreline Fish Monitoring
Project 4



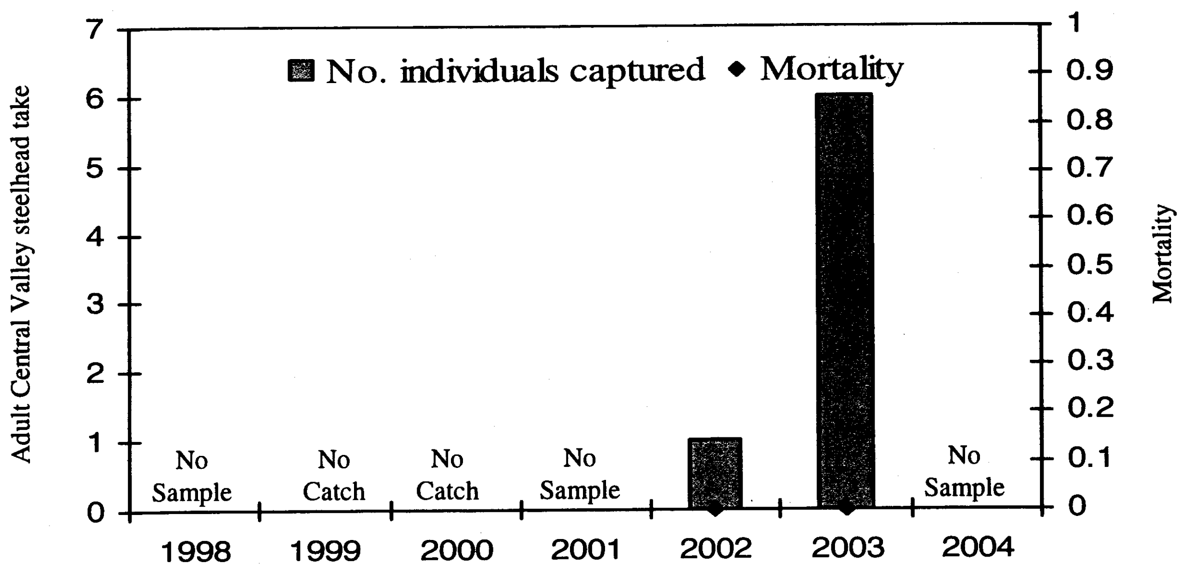


Figure 8d. Number of individual fish captured and corresponding mortality for each long-term project between 1998 and 2004.

Estuarine and Marine Fish Abundance and Distribution Survey
Project 5

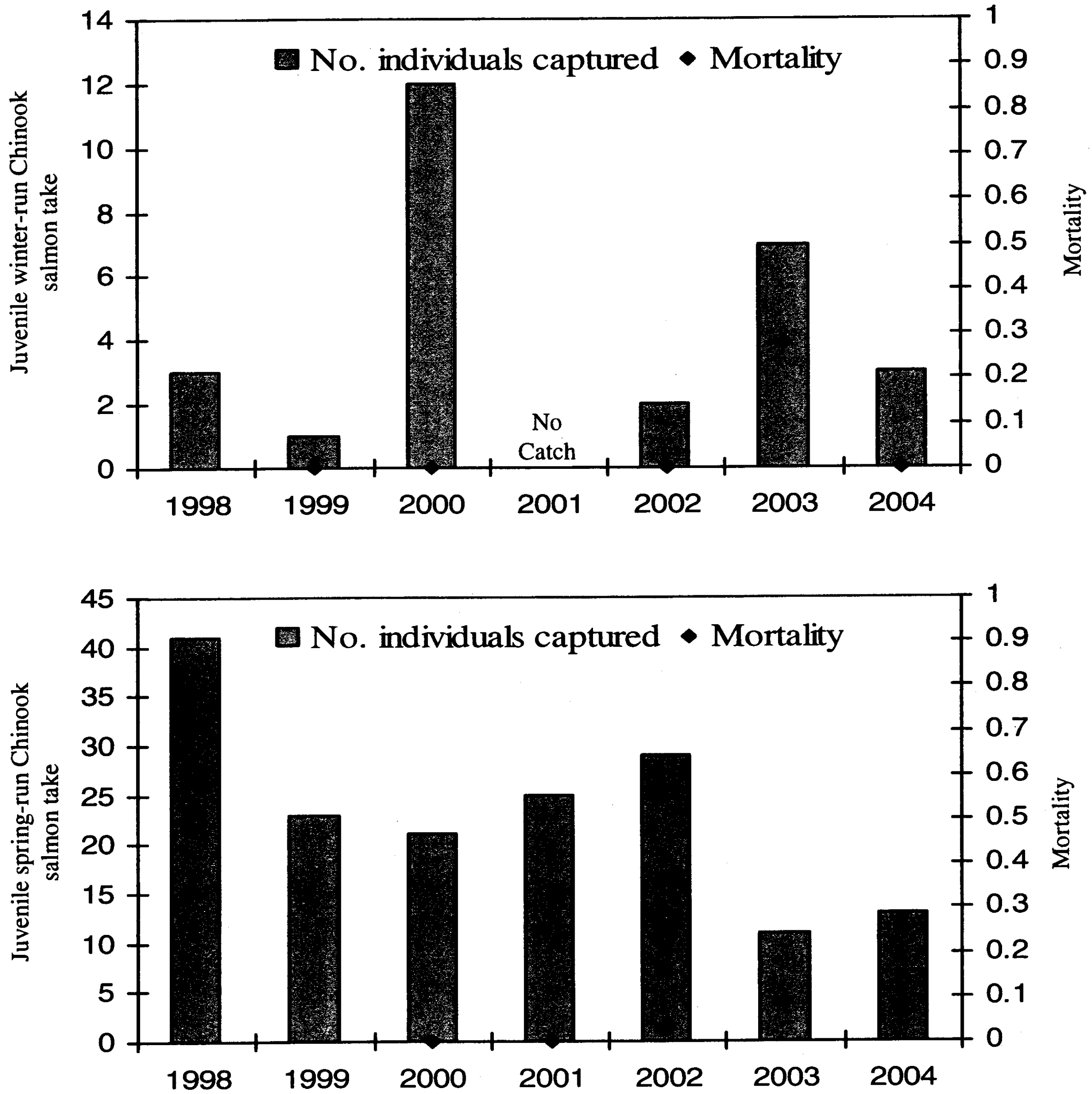


Figure 8e. Number of individual fish captured and corresponding mortality for each long-term project between 1998 and 2004.

Estuarine and Marine Fish Abundance and Distribution Survey
Project 5

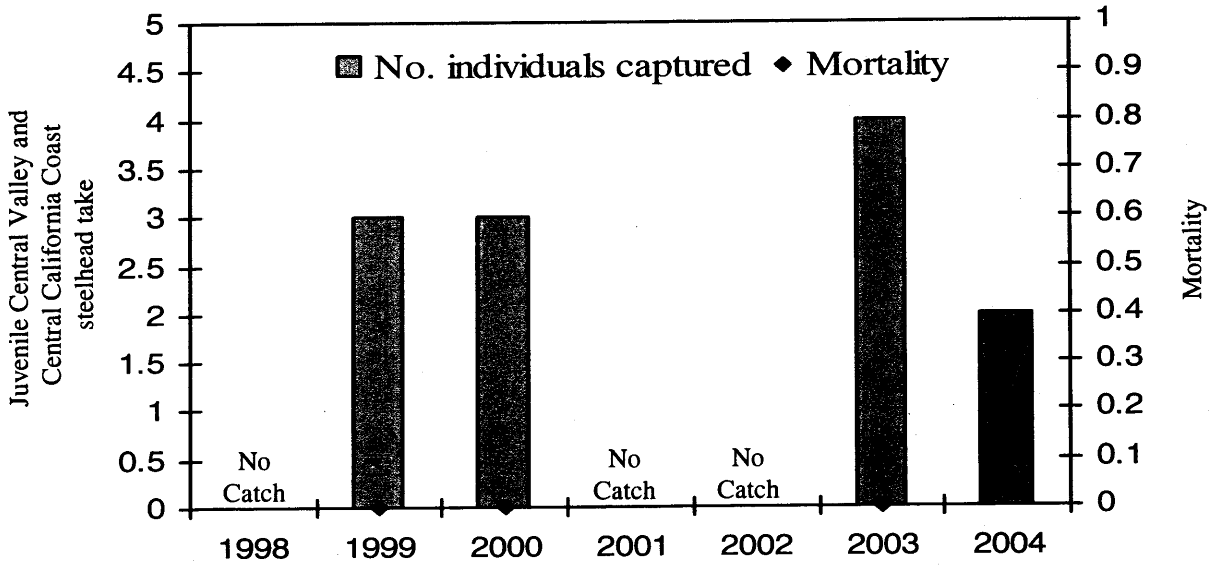
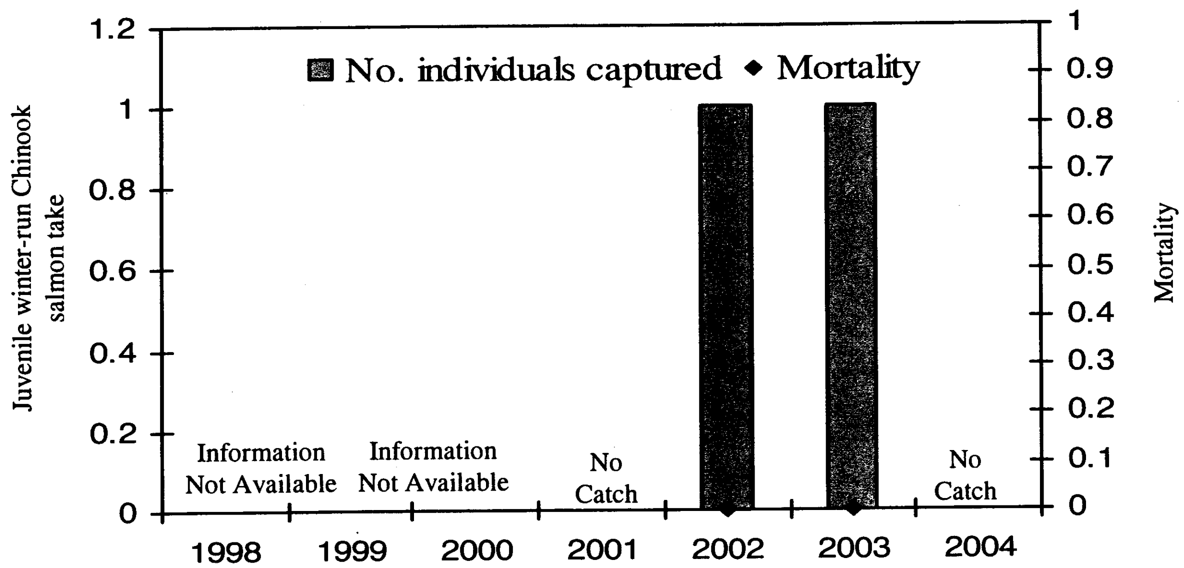


Figure 8e. Number of individual fish captured and corresponding mortality for each long-term project between 1998 and 2004.

Delta Smelt 20-mm
Project 6



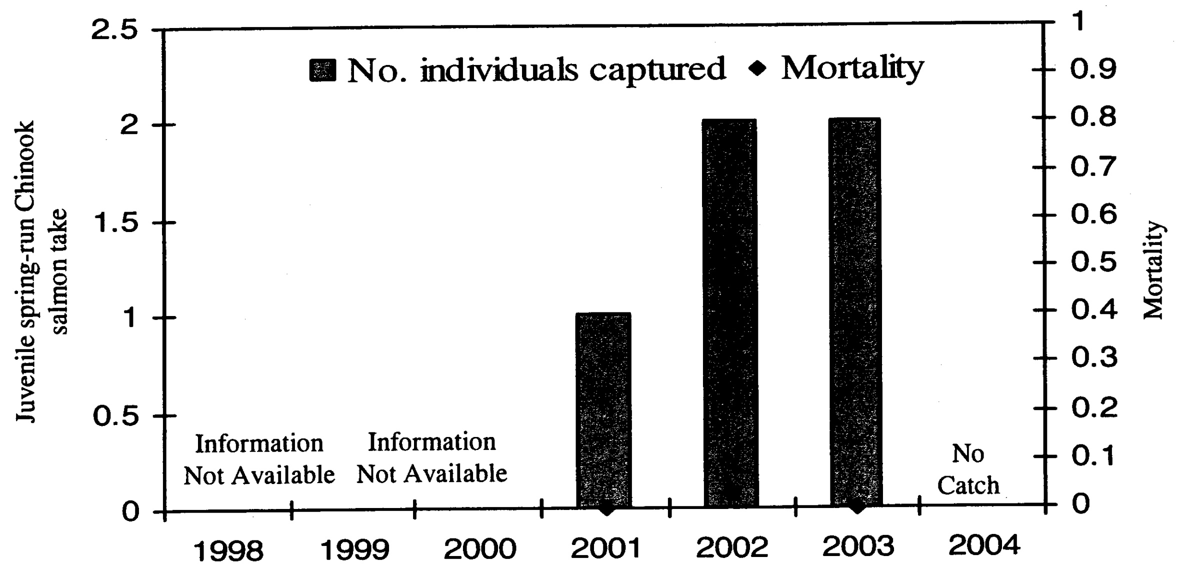


Figure 8f. Number of individual fish captured and corresponding mortality for each long-term project between 1998 and 2004.

Delta Smelt 20-mm
Project 6

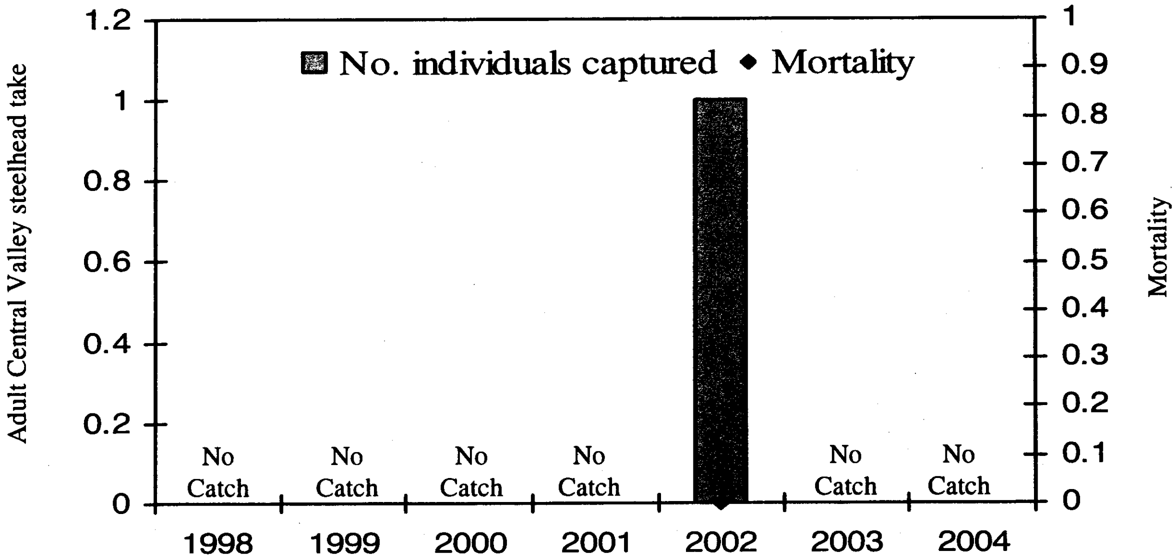
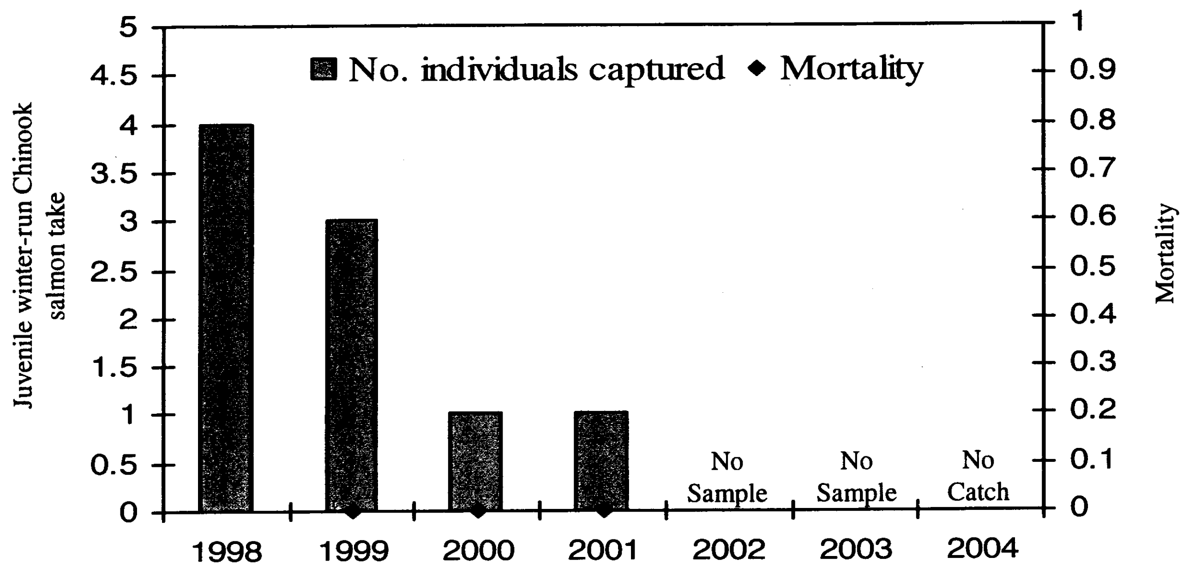


Figure 8f. Number of individual fish captured and corresponding mortality for each long-term project between 1998 and 2004.

Real Time Monitoring
Project 7



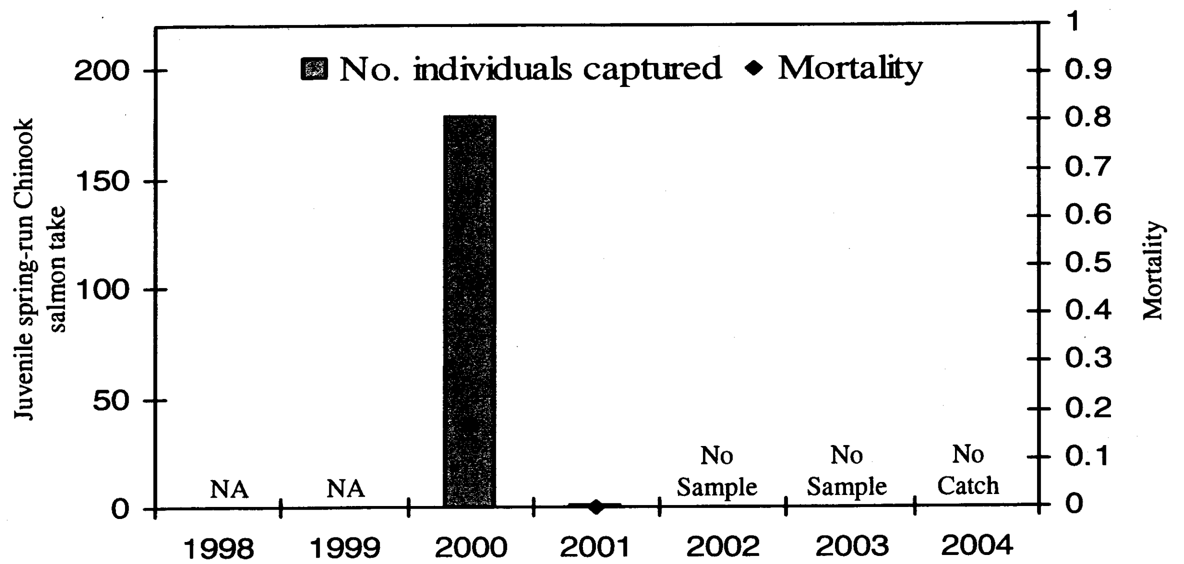


Figure 8g. Number of individual fish captured and corresponding mortality for each long-term project between 1998 and 2004.

Real Time Monitoring
Project 7

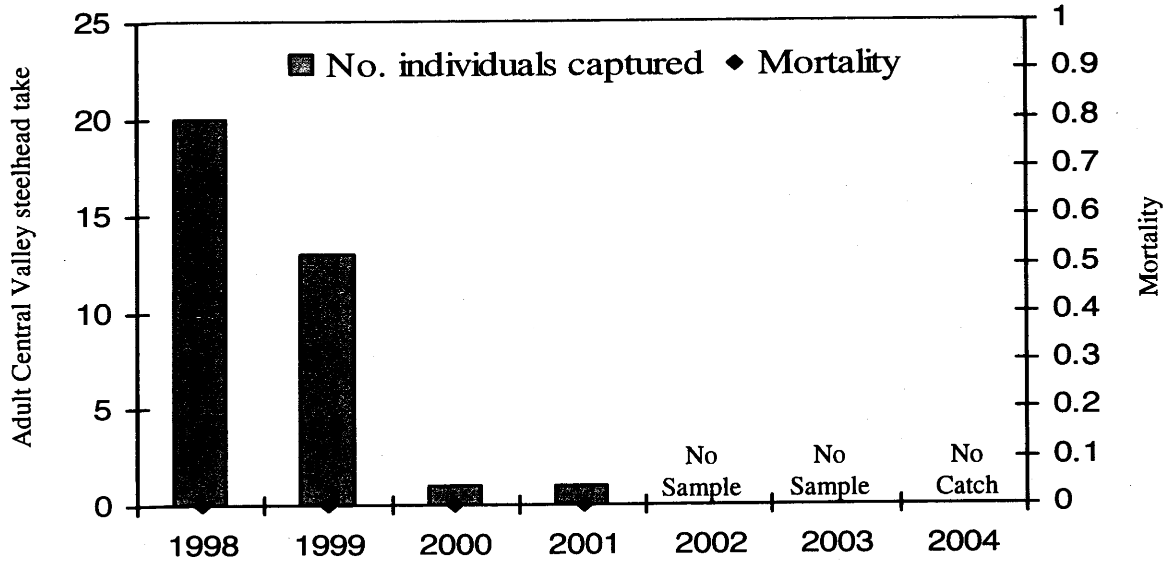


Figure 8g. Number of individual fish captured and corresponding mortality for each long-term project between 1998 and 2004.

Spring Kodiak Trawl Survey
Project 8

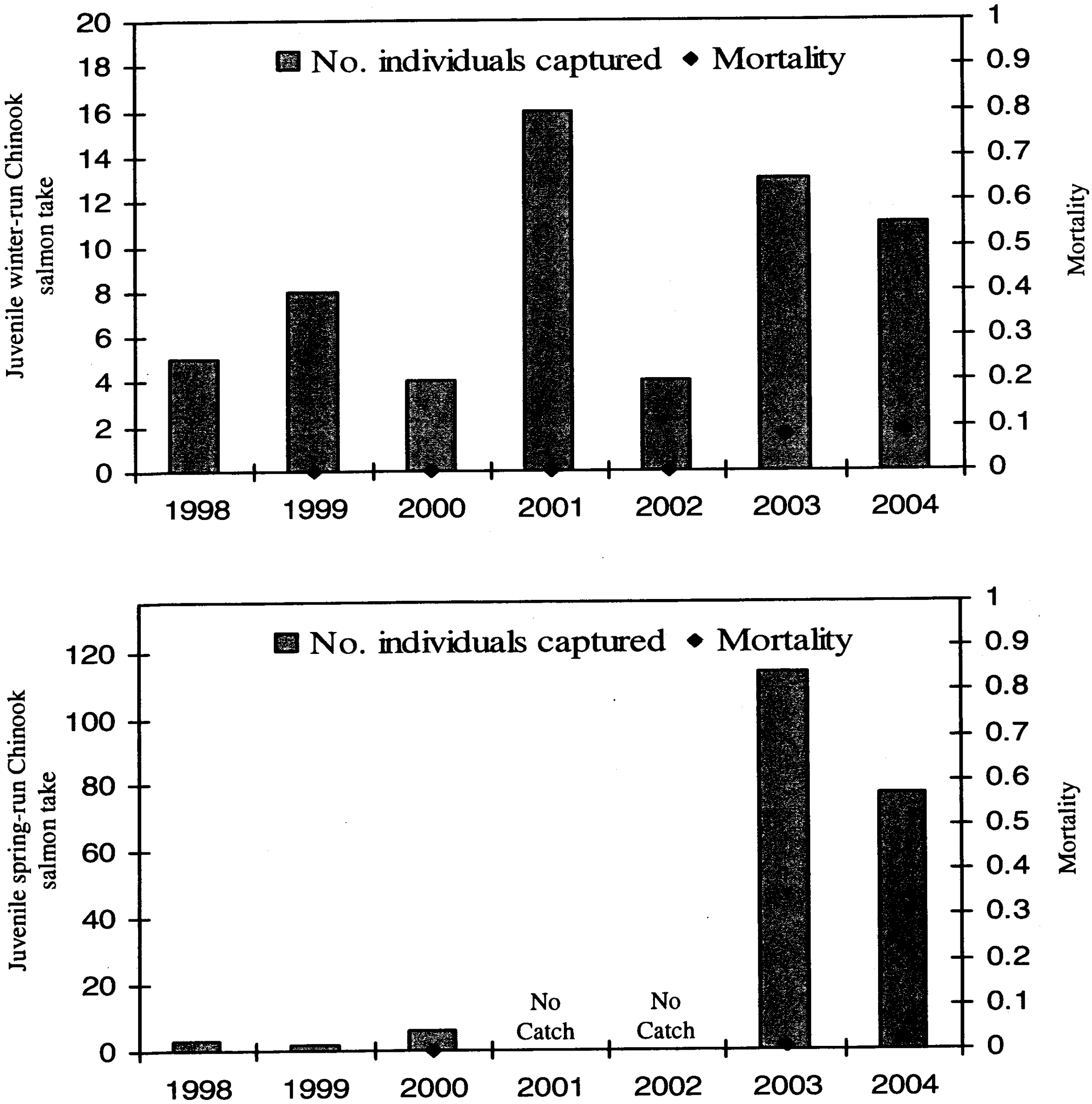


Figure 8h. Number of individual fish captured and corresponding mortality for each long-term project between 1998 and 2004.

Spring Kodiak Trawl Survey
Project 8

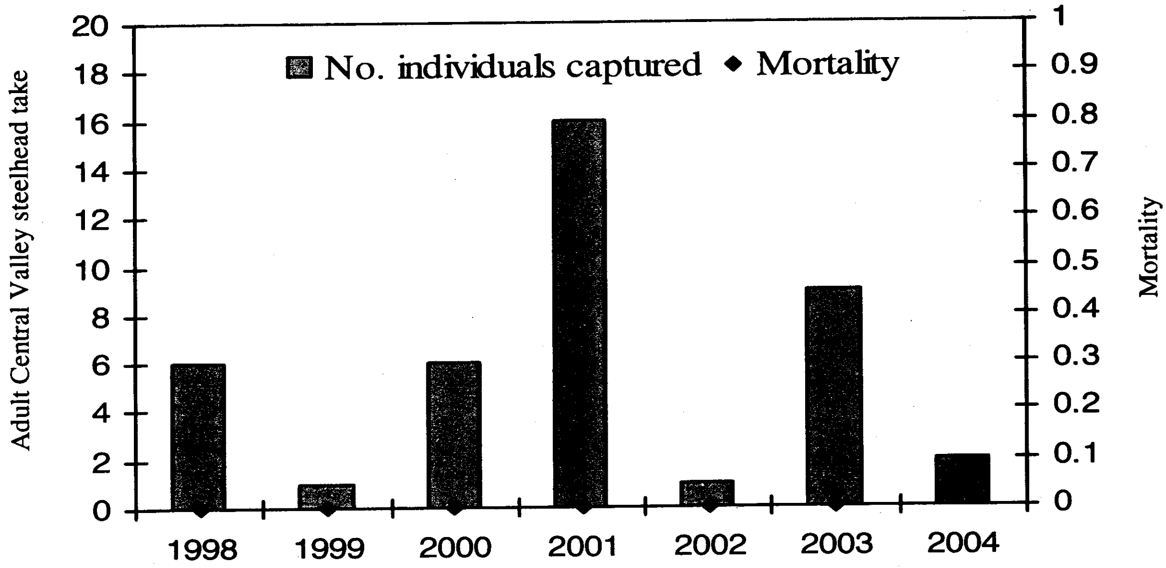


Figure 8h. Number of individual fish captured and corresponding mortality for each long-term project between 1998 and 2004.

UC Davis Suisun Marsh Fish Monitoring
Project 9

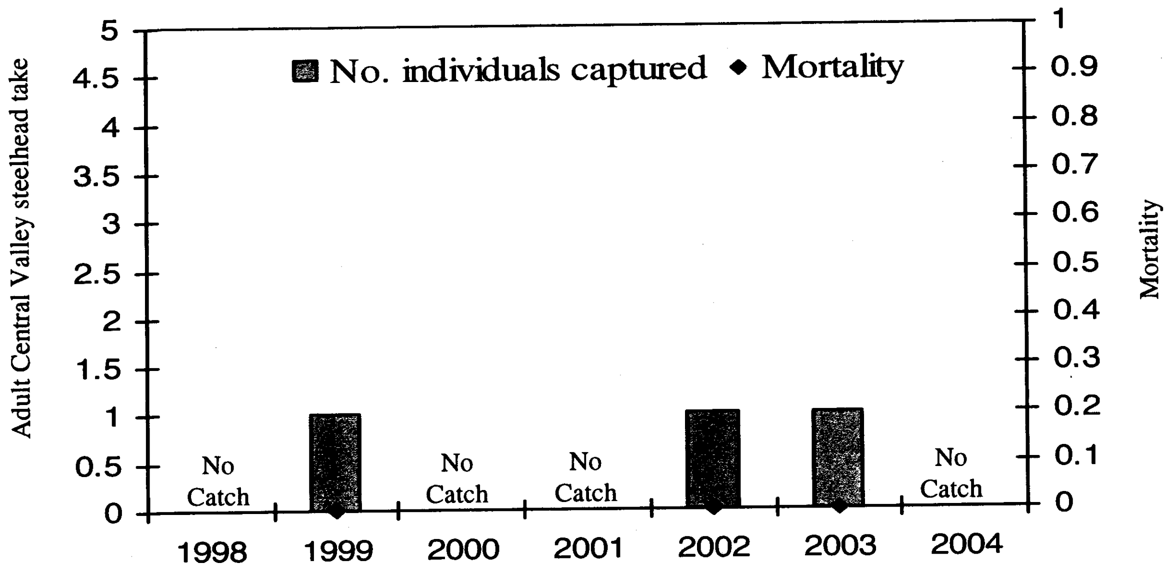
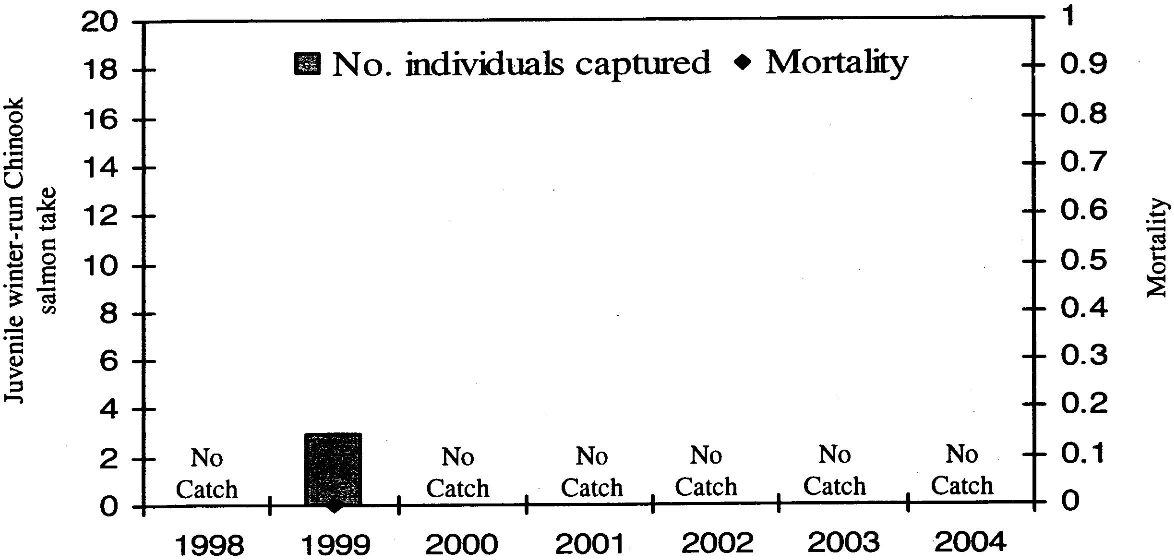


Figure 8i. Number of individual fish captured and corresponding mortality for each long-term project between 1998 and 2004.

South Delta Temporary Barriers Fish Monitoring
Project 10



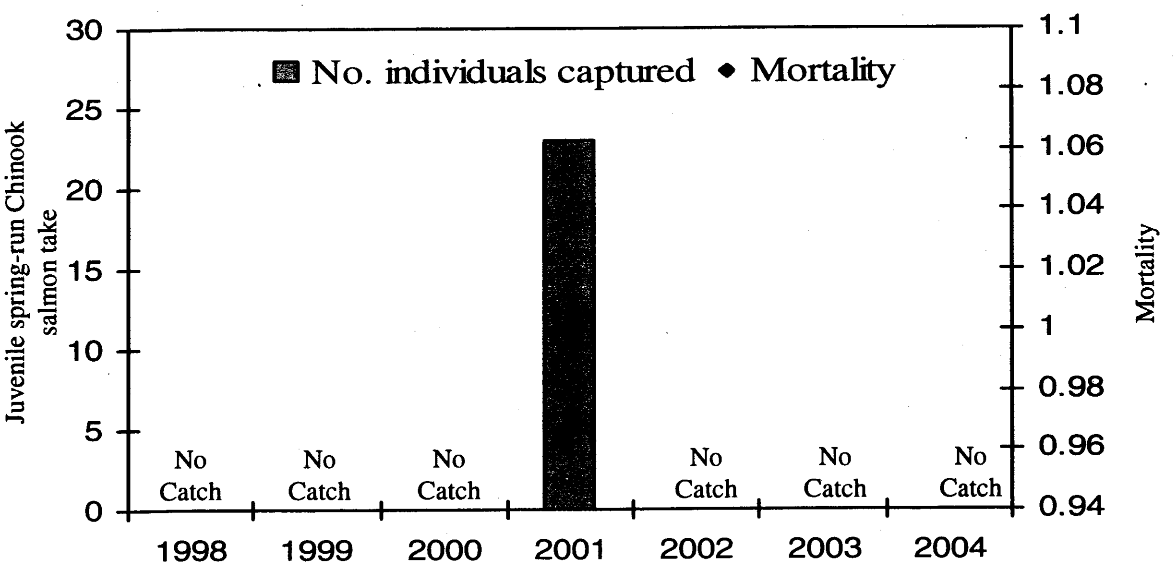


Figure 8j. Number of individual fish captured and corresponding mortality for each long-term project between 1998 and 2004.

South Delta Temporary Barriers Fish Monitoring
Project 10

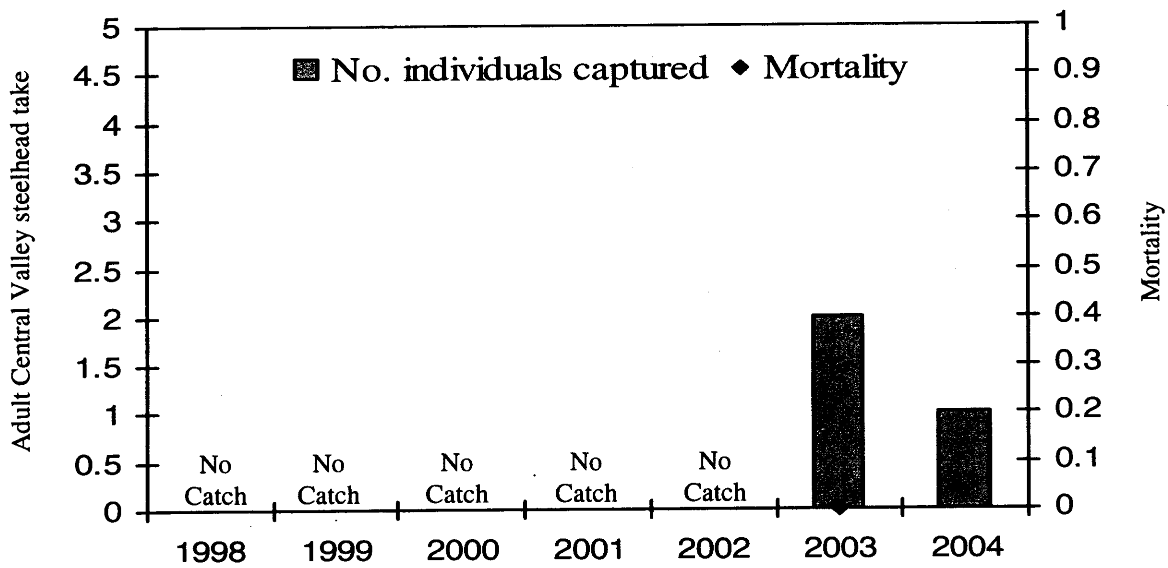
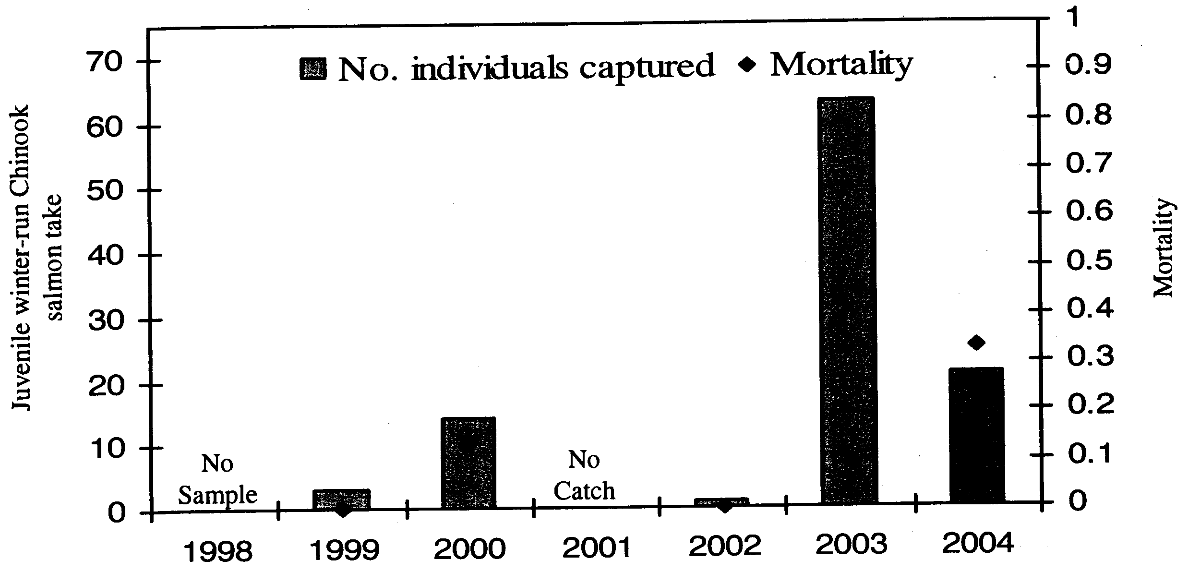


Figure 8j. Number of individual fish captured and corresponding mortality for each long-term project between 1998 and 2004.

Yolo Bypass Fish Monitoring
Project 11



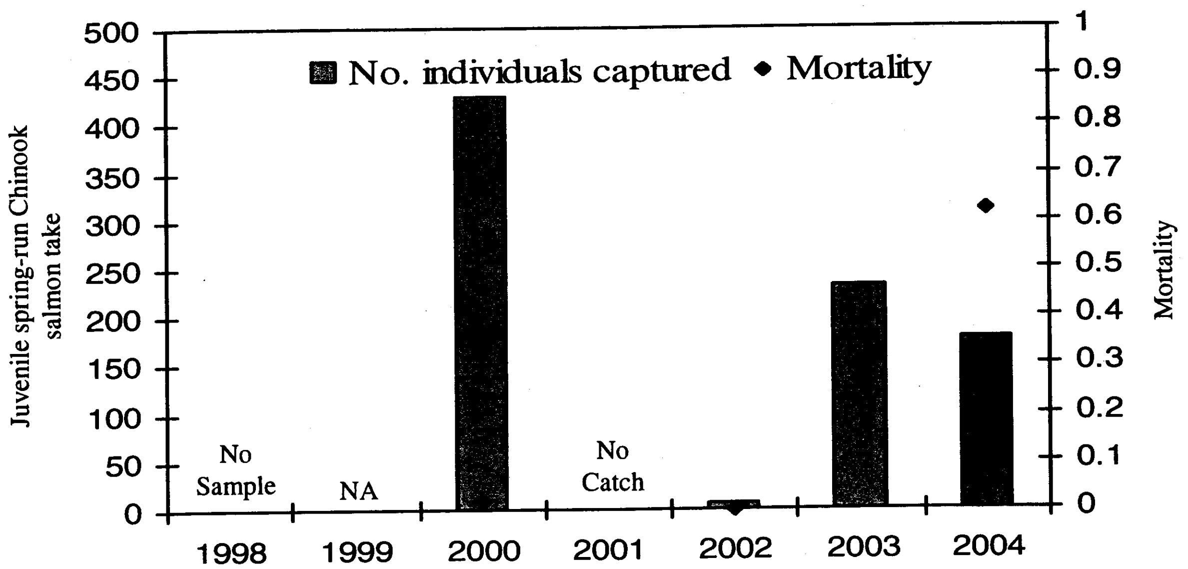


Figure 8k. Number of individual fish captured and corresponding mortality for each Short-term project between 1998 and 2004.

Yolo Bypass Fish Monitoring
Project 11

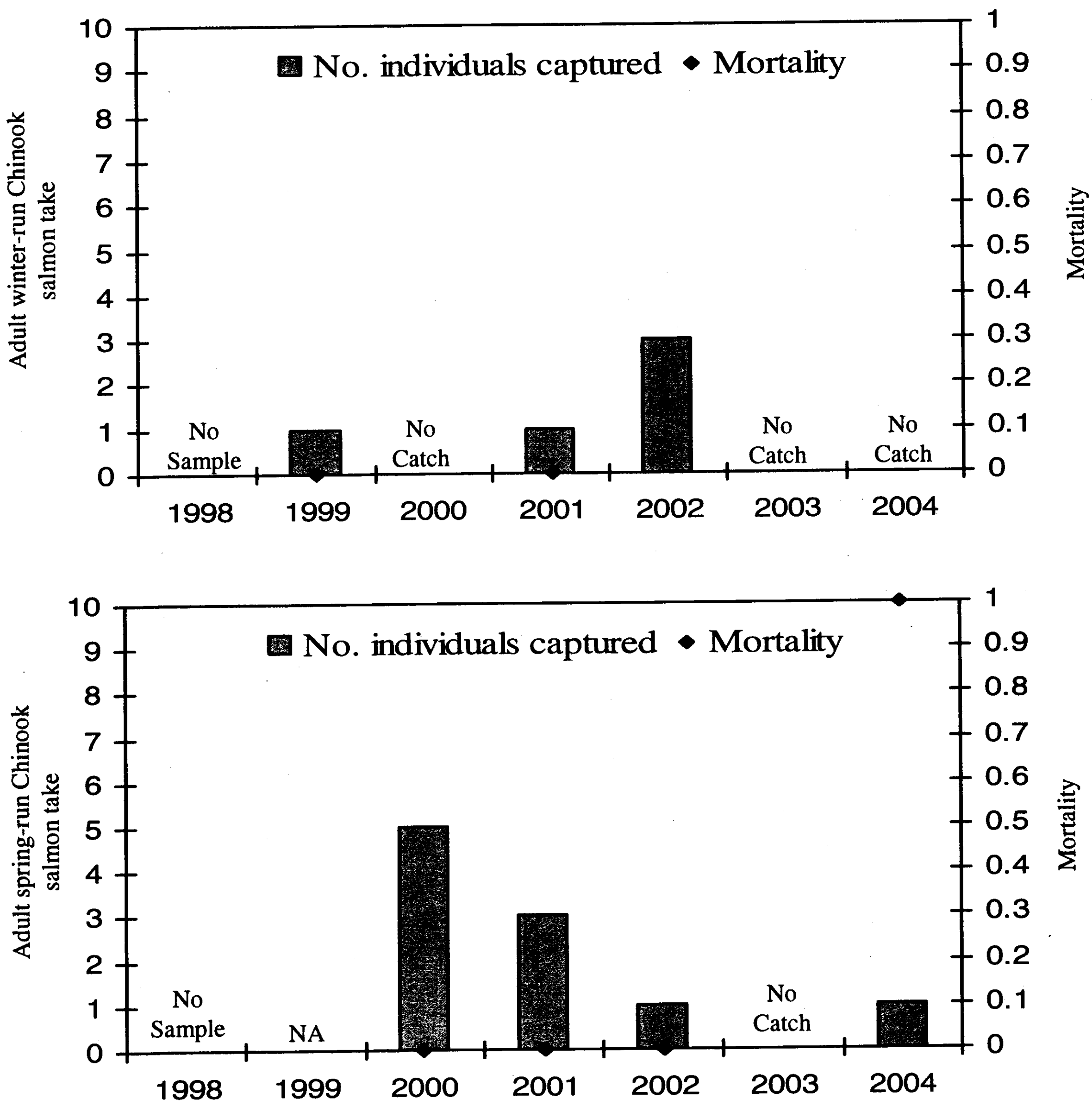
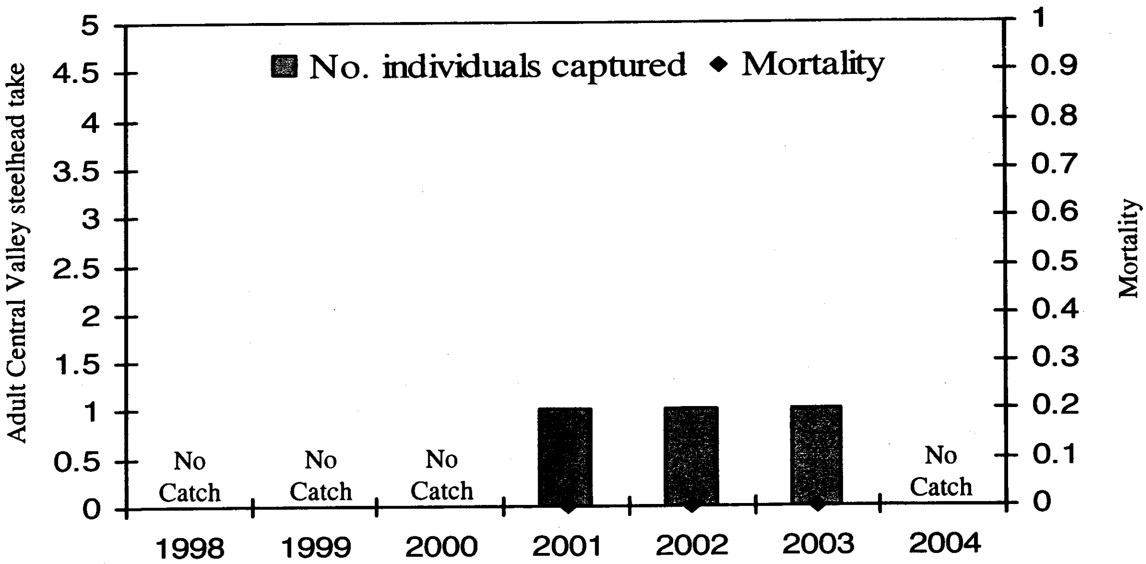


Figure 8k. Number of individual fish captured and corresponding mortality for each short-term project between 1998 and 2004.

Yolo Bypass Fish Monitoring
Project 11



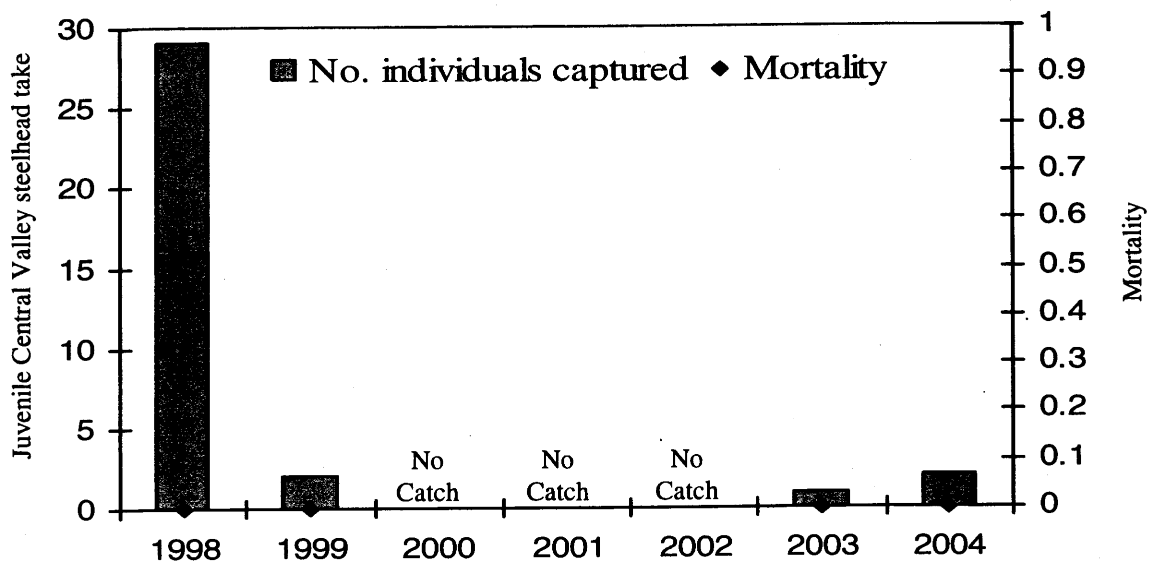
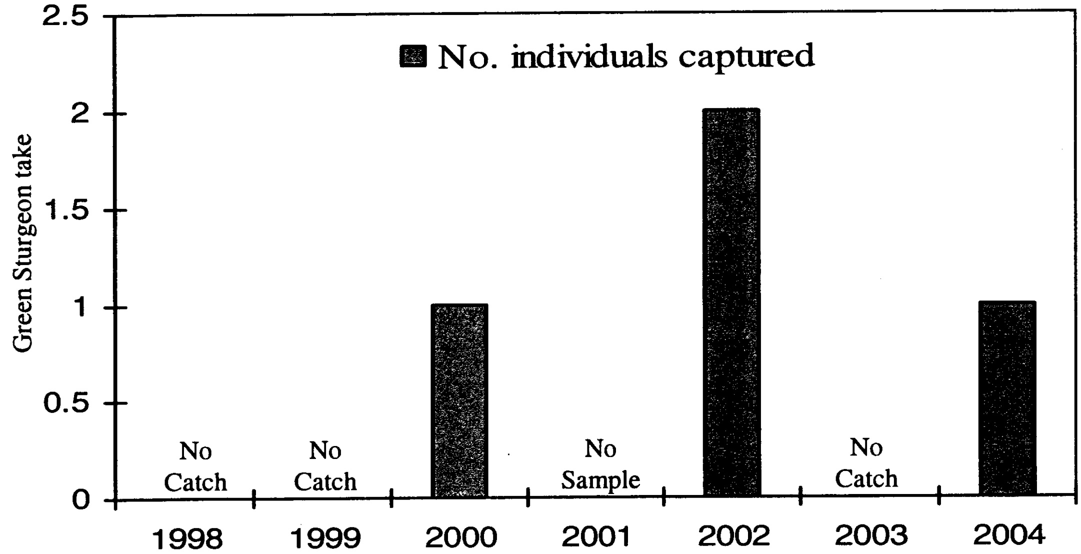


Figure 8k. Number of individual fish captured and corresponding mortality for each short-term project between 1998 and 2004.

Adult Striped Bass Population Parameters
Project 1



Adult Sturgeon Tagging
Project 3

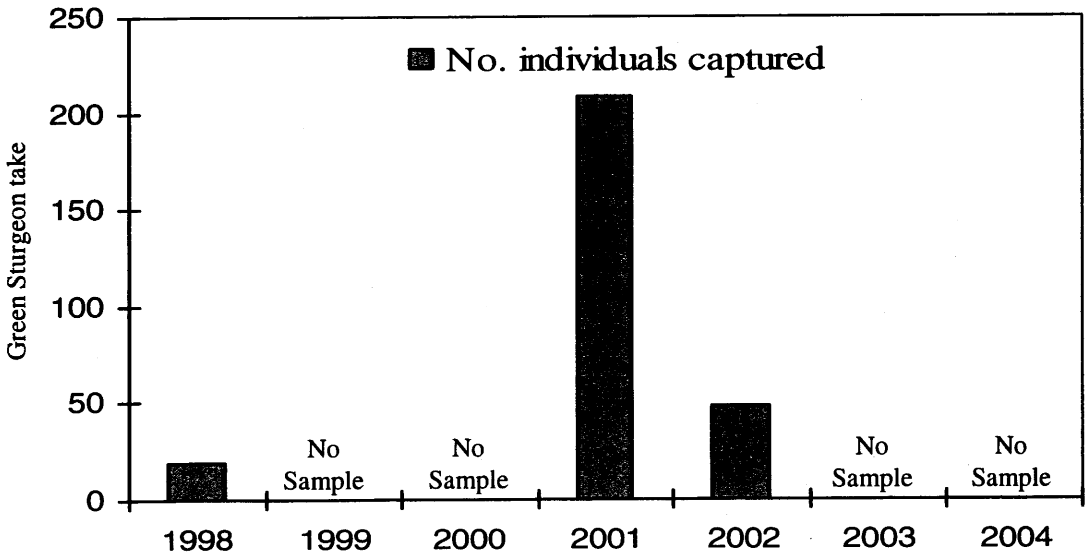


Figure 9. Number of individual North American green sturgeon captured by 3 long-term projects between 1998 and 2004.

Estuarine and Marine Fish Abundance and Distribution Survey
Project 5

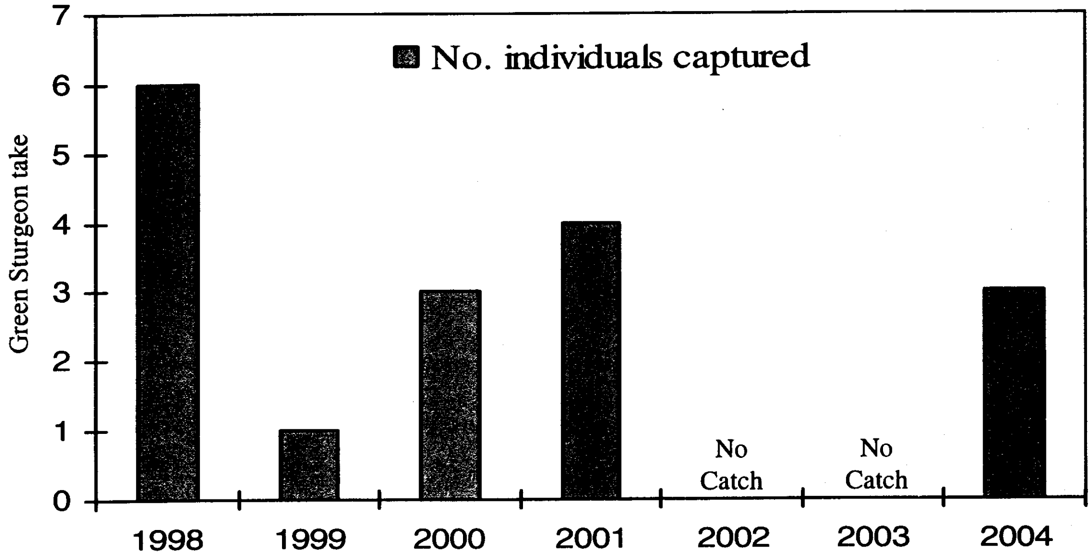


Figure 9. Number of individual North American green sturgeon captured by 3 long-term projects between 1998 and 2004.